

FISHERY MANAGEMENT PLAN
KENAI NATIONAL WILDLIFE REFUGE
FY 1996 - 2000

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EXECUTIVE SUMMARY

The Fishery Management Plan (Fishery Plan) for the Kenai National Wildlife Refuge (Kenai Refuge) provides management direction necessary to ensure conservation of refuge fishery resources and habitat, while maintaining sustainable harvests. The Fishery Plan outlines the purposes for which the refuge is managed and a resultant planning direction is achieved through development of management objectives and specific tasks. The planning effort is designed to span a five year period at which time it will be updated.

The refuge biological and physical environment is described and fishery resources, human use, management history, and major issues and concerns are discussed. Objectives and tasks are developed to address the issues and concerns. Major issues and concerns identified during the planning process included an incomplete baseline of fishery data, possible impact of enhancement activities on natural stocks, habitat degradation, and the need for additional law enforcement activities.

Objectives and tasks developed to address major concerns range from program administration to harvest regulation and data collection. Various management strategies and constraints are outlined to help guide implementation of fishery management activities. Many activities are joint tasks to be conducted by both the U.S. Fish and Wildlife Service (Service) and the Alaska Department of Fish and Game (Department). Service tasks are assigned annual costs and prioritized to allow selection of a program at any funding level.

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SECTION 1. INTRODUCTION

The Kenai National Wildlife Refuge (Kenai Refuge) was originally established as the Kenai National Moose Range by Executive Order 8979 on December 16, 1941. The Alaska National Interest Lands Conservation Act of 1980 (ANILCA) redesignated the area as a national wildlife refuge, added nearly a quarter of a million acres, and designated 1.35 million acres (550,000 ha) as Wilderness. Section 303.4 of ANILCA sets forth the following major purposes for which the Kenai Refuge was established and is to be managed including:

- (i) to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to moose, bears, mountain goats, Dall sheep, wolves and other furbearers, salmonoids and other fish, waterfowl and other migratory and nonmigratory birds;
- (ii) to fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats;
- (iii) to ensure, to the maximum extent practicable and in a manner consistent with the purposes set forth in paragraph (i), water quality and necessary water quantity within the refuge;
- (iv) to provide in a manner consistent with subparagraphs (i) and (ii), opportunities for scientific research, interpretation, environmental education, and land management training; and
- (v) to provide, in a manner compatible with these purposes, opportunities for fish and wildlife-oriented recreation.

The purposes of the Kenai Refuge, as stated in ANILCA, are unique among the 16 refuges in Alaska in two aspects. First, it is the only refuge where compatible fish and wildlife-oriented recreation is a major purpose. Second, Kenai is the only refuge where subsistence use was not specifically identified as a major purpose. Although subsistence use was not specifically listed as a major purpose for the refuge, Title VIII of ANILCA established subsistence as a priority use on all federal land in Alaska.

Section 304 of ANILCA requires the preparation and periodic revision of a Comprehensive Conservation Plan (Conservation Plan) for each refuge. The final Conservation Plan for the Kenai Refuge was completed in January, 1985 (U.S. Fish and Wildlife Service 1985). One function of the Conservation Plan is to specify a program for management and conservation of refuge fishery resources. The Kenai Refuge Fishery Management Plan (Fishery Plan) is a five year plan which specifies goals, objectives, and tasks to be achieved and implemented in managing fisheries on the refuge. Every three to five years the U.S. Fish and Wildlife Service (Service) will review public comments, staff recommendations, research studies, and state recommendations to determine if any revisions to the plan are necessary. If major changes

are proposed, the public and state will be provided opportunities to participate in revisions of the plan.

SECTION 2. GENERAL PHYSICAL AND BIOLOGICAL ENVIRONMENT

Setting

The Kenai Refuge covers 797,000 hectares (1,970,000 acres) on the Kenai Peninsula in southcentral Alaska (Figure 1). The eastern third of the refuge lies within the Kenai Mountains which range in elevation from 914 to 2,012 m (3,000 to 6,600 ft). The entire range is heavily glaciated and many of its high valleys are buried beneath the vast Harding Ice Field. The remaining two-thirds of the refuge, the Kenai Lowlands, are part of the Cook Inlet Lowlands. These lowlands consist of ground moraines and stagnant ice terrain with low ridges, hills, and muskeg. Relief ranges from 15 to 76 m (50 to 250 ft) and most of the land is less than 152 m (500 ft) above mean sea level. This area contains thousands of lakes. The lowlands are within the Cook Inlet Sedimentary Basin, the reservoir for oil and gas beneath the refuge.

Climate

The climate of southcentral Alaska is subarctic. Temperatures on the Kenai Peninsula rarely rise above 26°C (80°F) in the summer or drop below -34°C (-30°F) in the winter. The average annual temperature on the refuge is 0.7°C (33.2°F). Extended periods of temperatures below -18°C (0°F) are rare.

Wind velocities rarely exceed 70 km/hr (38 knots) and average about 11 km/hr (6 knots) at lower elevations. Annual precipitation on the western border of the Kenai Peninsula ranges from 48 cm (19 in) at Kenai to 58 cm (23 in) at Homer. On the mountainous eastern parts of the peninsula, precipitation exceeds 102 cm (40 in) annually.

Soils

Lowland portions of the peninsula are mantled by glacial deposits that vary in texture and are overlain by well-drained to poorly drained silt loams. Depression areas such as muskeg are usually covered by peat soils produced by the slow decomposition of organic materials in the subarctic climate. Although some of the soils can be productive most are considered submarginal for agriculture. Sloped areas are vulnerable to erosion, especially if the vegetative cover is removed.

Water Resources

The Kenai Refuge offers a variety of aquatic resources (Figure 2). There are about 2,400 km (1,500 mi) of streams. The Kenai River, the largest watershed on the refuge, drains about 5,563 km² (2,148 mi²). About 54% of this watershed is on the refuge, 37% is in the Chugach National Forest, and the remainder is on private lands. Ten major tributaries on the refuge feed the Kenai River system: Beaver Creek, Slikok Creek, Funny River, Moose River, Killey River, King County Creek, Hidden Creek, Skilak River, Jean Creek, and the Russian River. Other refuge river systems flowing directly into the Cook Inlet include the

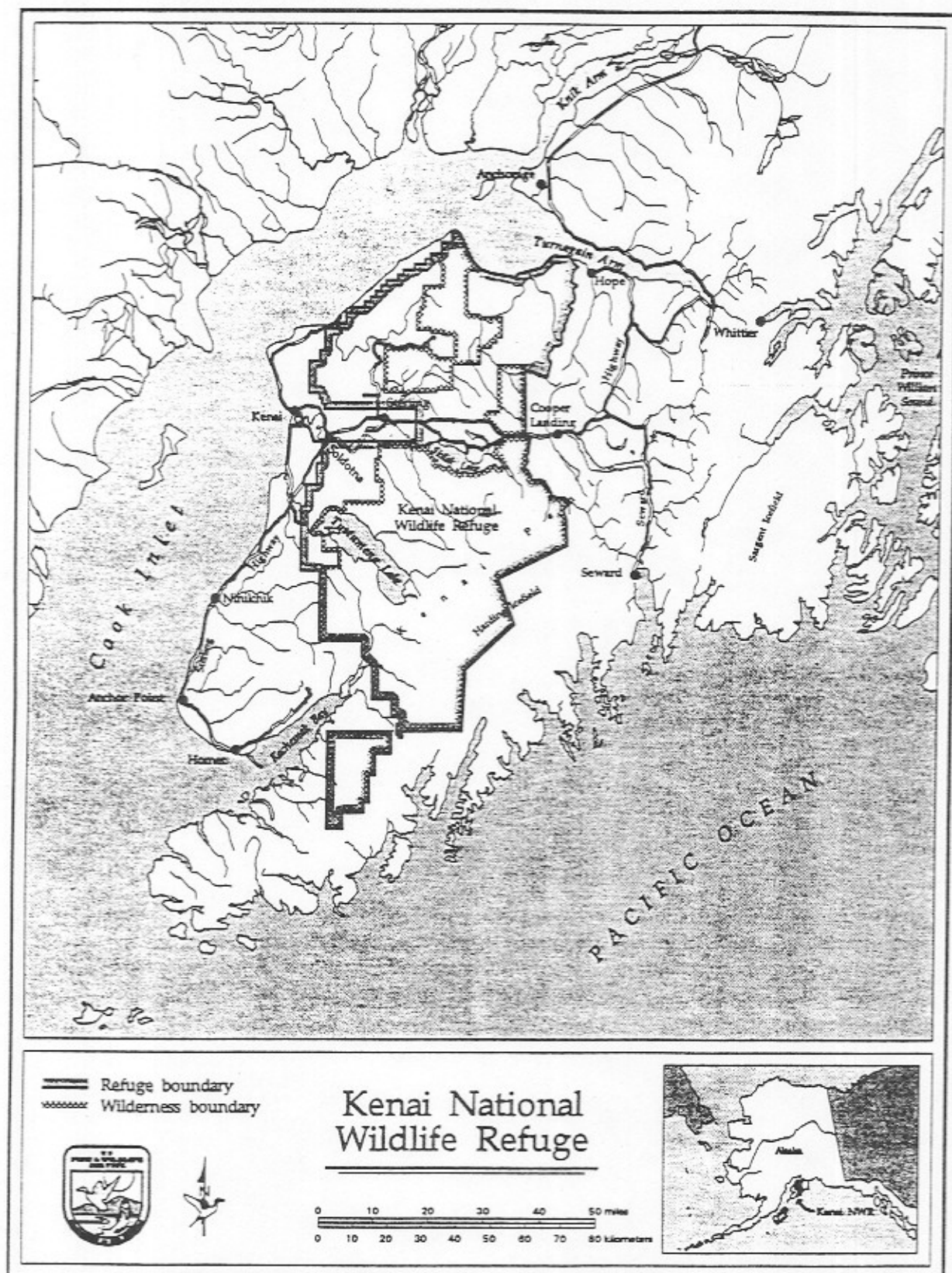


Figure 1.—Location of the Kenai National Wildlife Refuge.

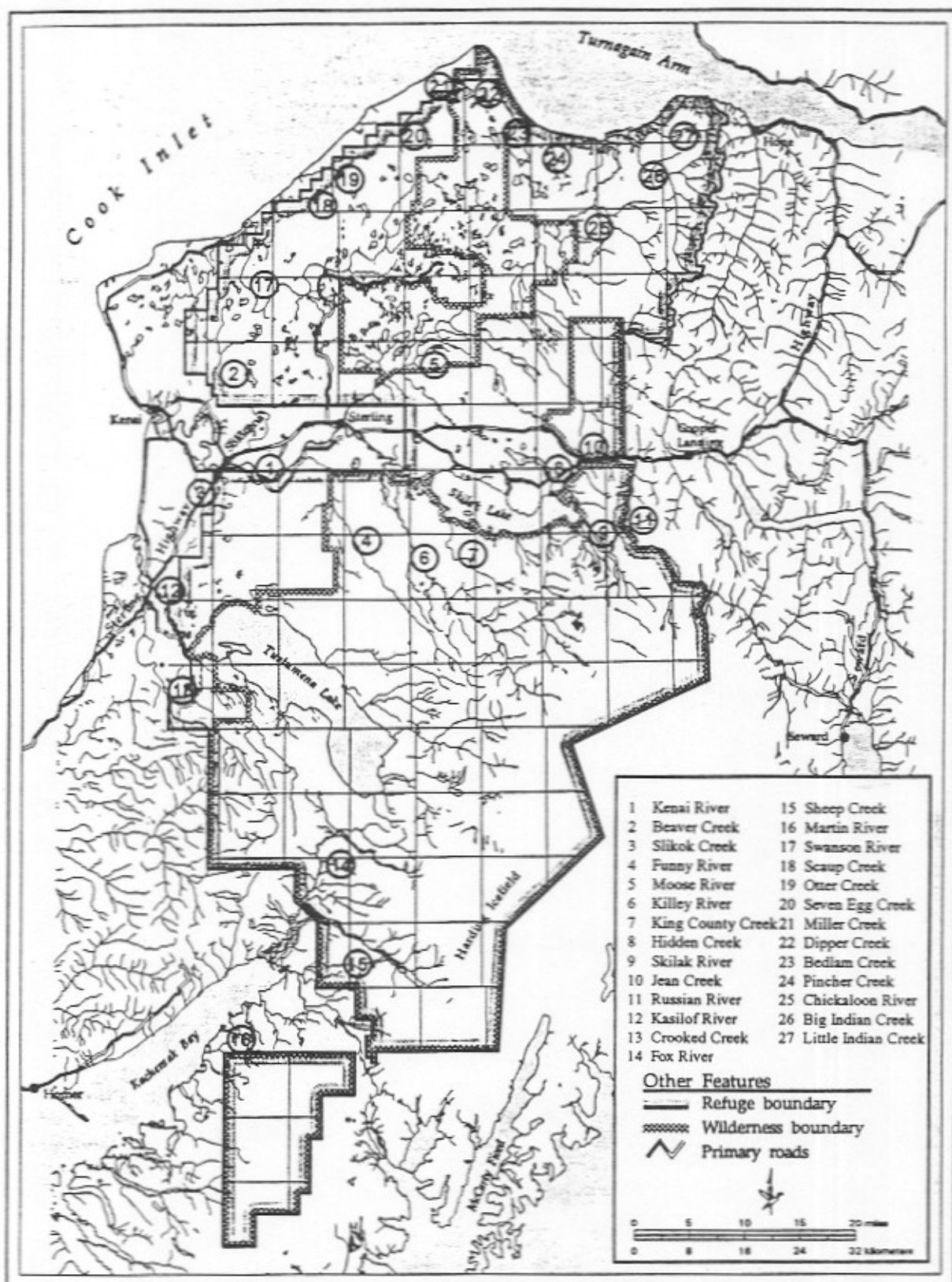


Figure 2.—Watersheds on the Kenai National Wildlife Refuge.

Kasilof and Swanson rivers and Seven Egg, Otter, Scaup, and Miller creeks. The Fox and Martin rivers and Sheep Creek flow into Kachemak Bay while the Chickaloon River and a number of smaller streams, such as Big and Little Indian, Pincher, Bedlam, and Dipper creeks, flow into Turnagain Arm. Physical characteristics of all watersheds within the Kenai Refuge are summarized on Tables 1 and 2.

There are 808 lakes on the Kenai Refuge with surface areas of 4 hectares (10 acres) or larger (Table 3). The total surface area of these lakes covers about 59,092 hectares (146,018 acres). The largest are two glacial lakes, Tustumena Lake (29,450 hectares or 72,770 acres) and Skilak Lake (9,995 hectares or 24,696 acres) (Figure 2). Smaller lakes dot the refuge, but occur primarily in the Moose, Swanson, and Chickaloon river drainages. Several hundred lakes smaller than 4 hectares (10 acres) occur on the refuge, but many of these lakes do not support sport fish populations (U.S. Fish and Wildlife Service, unpublished data).

Most lakes are frozen from November to May; streams freeze later and thaw earlier. Summer water temperatures rarely exceed 20°C (68°F). The high-flow period for glacial streams is in summer during the maximum glacier-melt. Variations in stream flows tend to be gradual due to the moderating effects of ice melt, spring seepage, and low precipitation rates.

Streams originating from glaciers carry finely suspended silt that gives them a milky appearance and reduces light penetration. Runoff waters, however, are usually clear except during heavy runoff. In some areas they are stained by organic tannins leached from partially decomposed vegetation. The dissolved mineral content of both runoff and glacial waters is generally low. Most lakes and streams are slightly alkaline to slightly acidic, and oxygen content is usually high during summer. Oxygen becomes depleted in some lakes and streams during the winter when they are covered with ice and snow. Some lake bottoms and most stream beds are composed of various-sized gravels. Streams and lakes vary greatly in depth, flow characteristics, configuration, and the amount of aquatic vegetation and detritus.

Water Rights

Federal reserved water rights are created when federal lands are withdrawn from entry for federal use. They are created for the minimum amount of water reasonably necessary to satisfy both existing and reasonable foreseeable future uses of water for the primary purposes for which the land is withdrawn. The priority date is the date the land is withdrawn for the primary purposes.

Federal reserved water rights in Alaska can be claimed and adjudicated in basin-wide adjudications in conformance with the McCarran Amendment under state law, AS 46.15.165-169 and 11 AAC 93.400-440, either administratively or judicially. Alternatively, federal water rights may be applied for and granted under state law for either out-of-stream or

Table 1.—Physical characteristics of watersheds in the Kenai River drainage within the Kenai National Wildlife Refuge.

Watershed	Size		Length		Mean gradient		Percent off refuge	Percent glaciated
	km ²	mi ²	km	mi	m/km	ft/mi		
Kenai River	5,563	2,148	132	82	1.1	6	46	11
Moose River	648	250	45	28	0.9	5	4	0
Killey River	554	214	79	49	10.4	55	1	9
Skilak River	433	167	14	9	7.4	39	20	51
Funny River	329	127	51	32	21.4	113	6	0
Russian River	163	63	37	23	11.9	63	48	1
Beaver Creek	132	51	23	14	0.9	5	30	0
Slikok Creek	96	37	16	10	3.6	19	40	0
Hidden Creek	62	24	5	3	6.4	34	0	0
King County Creek	36	14	18	11	36.3	192	0	0
Jean Creek	34	13	8	5	8.3	44	0	0

Table 2.—Physical characteristics of watersheds on the Kenai National Wildlife Refuge.

Watershed	Size		Length		Mean gradient		Percent off refuge	Percent glaciated
	km ²	mi ²	km	mi	m/km	ft/mi		
Kenai River	5,563	2,148	132	82	1.1	6	46	11
Kasilof River	2,150	830	29	18	1.1	6	6	20
Chickaloon River	798	308	76	47	4.7	25	10	0
Swanson River	717	277	77	48	0.8	4	1	0
Fox River	482	186	40	25	10.6	56	17	16
Sheep Creek	337	130	24	15	51.4	272	9	36
Big Indian Creek	150	58	31	19	24.8	131	0	0
Seven Egg Creek	109	42	19	12	2.8	15	14	0
Pincher Creek	85	33	13	8	3.2	17	0	0
Otter Creek	52	20	11	7	3.8	20	9	0
Scaup Creek	49	19	8	5	7.0	37	10	0
Martin River	41	16	11	7	40.3	213	59	3
Little Indian Creek	41	16	13	8	65.4	346	0	0
Bedlam Creek	39	15	10	6	5.9	31	0	0
Miller Creek	28	11	6	4	4.9	26	31	0
Dipper Creek	28	11	3	2	6.4	34	0	0

Table 3.-Number and size of selected lake types occurring on the Kenai National Wildlife Refuge. Lakes less than 4 hectares are excluded.

Category	Size class in hectares (acres)					Total
	4-20 (10-50)	21-40 (51-100)	41-202 (101-500)	203-405 (501-1000)	405+ (1000+)	
Total number of lakes	574	129	98	3	4	808
Total surface area (hectares)	5,807	3,915	7,921	877	40,572	59,092
Total surface area (acres)	14,350	9,675	19,573	2,167	100,253	146,018
Lakes with inlets or outlets	128	55	44	3	4	234
Lakes with ocean connection	71	34	26	2	4	137
Total surface area-ocean connected lakes (hectares)	718	971	2,510	569	40,572	45,340
Total surface area-ocean connected lakes (acres)	1,775	2,400	6,203	1,407	100,253	112,038
Lakes with documented sport fish populations	14	26	40	2	4	86
Lakes with road access	59	15	20	0	3	97

instream water rights. In any case, water claimed or requested must be quantified.

The Service will work cooperatively with the State of Alaska to inventory and quantify its federal water rights under state law. Water resources of the Kenai Refuge will be managed to maintain the primary purposes for which the refuge was established.

The State of Alaska acknowledges the specific status of certain waterbodies on the Kenai Refuge, including the Tustumena Lake court decision; the Kenai River Special Management Area; the Memorandum of Understanding among the Department of Natural Resources, the U.S. Fish and Wildlife Service and the U.S. Forest Service for Skilak Lake and the upper Kenai River; and the Swanson River/Swan Lakes National Recreation Trails.

Wilderness

Congress designated 1.35 million acres (550,000 ha) or about 69% of the Kenai Refuge as Wilderness through ANILCA. Wilderness areas on the Kenai Refuge consist of three separate units: the Lowland Unit, which includes the Swan Lake and Swanson River Canoe Routes; the Mystery Creek Unit; and the Andrew Simons Unit. Wilderness areas are managed in accordance with the provisions of the Wilderness Act, the National Wildlife Refuge System Administration Act, Federal regulations (50 CFR), and Service policy. These legal mandates affect recreational and commercial uses, methods of travel, trails, facilities, and signing.

Petroleum Resources

The Kenai Refuge lies within the Cook Inlet Tertiary Petroleum Province. Prior to ANILCA, approximately 312,000 hectares (771,000 acres) or 45% of the refuge was opened to leasing. Wilderness designations in ANILCA reduced the area subject to future leasing to about 217,000 hectares (536,000 acres), as oil and gas leasing is prohibited in Wilderness.

Many oil and gas leases have been issued on the refuge since 1958. Presently, there are 4,860 hectares (12,000 acres) of active oil and gas leases including pipeline rights-of-way.

The first substantial commercial oil discovery in Alaska occurred in 1957 within what is now the Swanson River Oil Field. That discovery quickly developed into a major field, which to date has produced over 200 million barrels of oil. A pipeline across the refuge between the Swanson River Oil Field and the coastal town of Nikiski 32 km (20 miles) to the west carries the crude oil to market. Nearly 100 wells have been drilled in this 3,200-hectare (8,000-acre) field. Numerous support facilities have been built, including over 53 km (33 mi) of access roads.

Natural gas production is expected to begin when extraction of economically recoverable oil is completed. About 6,513,000 m³ (230

million cubic feet) of gas are re-injected into the field daily to maintain formation pressure for oil production.

Three smaller gas/oil fields are located on the refuge. These are the Beaver Creek, Birch Hill and West Fork fields.

Vegetation

The vegetation of the refuge can be subdivided into three major classes: 1) humid coastal forests dominated by Sitka spruce; 2) interior forests of white and black spruce mixed with birch; and 3) mountain tundra, including glaciers and snowfields.

Forests cover 39% of the refuge. Forests of black spruce alternate with peatbogs and grassy mires on 7% of the refuge. White spruce forests are distributed in the drier areas and in the foothills and mountains. They are often intermixed with or include deciduous trees such as white birch, especially in old burns and cut-over areas. Aspen is also found with white spruce and birch.

Mountain tundra covers about 13% of the refuge. Of this class about 87% is dwarf shrub and lichen tundra, and 13% is tall shrub (alder and willow) thickets usually associated with tundra.

Wetlands and riparian habitats comprise about 11% of the refuge. These habitats have special values that are derived primarily from their proximity to water rather than from the plant communities and successional stages present. Wetland and riparian habitats are essential to 36 species of birds and are used by every other species occurring on the refuge. Other important functions of these habitats include rearing habitat for juvenile salmonids, flood control, a source of detritus and nutrients for the aquatic food web, and pollution abatement by acting as a filter of surface runoff.

Wildlife

At least 199 species of amphibians, birds, and mammals permanently reside in, seasonally use, or are rare visitors on the Kenai Refuge. Several of these species are fish eating birds and mammals. Fish eating birds include several species of gulls and terns, cormorants, three species of loons, mergansers, grebes, kingfishers, osprey, and bald eagles. In winter, 300-600 bald eagles gather along the upper Kenai River to feed on winter spawning coho salmon. A smaller group of eagles gathers on the lower Fox River during May, apparently to feed on spawning eulachon. Avian scavengers which eat fish include ravens, magpies, and Canada jays.

Fish eating mammals include mink, river otter, and black and brown bears. Returning salmon play an important role in the distribution of bears on the refuge. Both species of bears are attracted by spawning salmon concentrations. Salmon are especially important to brown bears and several salmon streams have been identified and included in

essential brown bear habitat on the refuge. Salmon streams important to brown bears include the Russian, Funny, and Chickaloon rivers and Goat, Hidden, Bear, and Benjamin creeks (Jacobs 1989).

SECTION 3. FISHERY RESOURCES

The subarctic stream and lake habitats and associated populations of salmon, trout, char, and other species (Table 4) are highly important resources of the Kenai Refuge. Most of the aquatic habitats are in near-pristine condition and many of the fish species have significant recreational and commercial value.

Refuge salmon stocks are economically and ecologically important to the Kenai Peninsula. The national importance of these resources is particularly evident when they are compared to habitats and fish populations elsewhere in the nation, where many resources have been severely impacted by human expansion and development.

The productivity of aquatic habitats in this subarctic region depends on maintenance of high water quality, proper water temperature, clean stream gravels, and nutrient-exchange cycles driven by anadromous fish runs. Welfare of the fish populations is dependent upon maintaining genetic variability, protection of critical rearing and spawning habitats, and escapement of sufficient spawning stocks.

Species Descriptions

Chinook Salmon

The chinook salmon is the largest of the five species of North American salmon. They spawn mostly in large freshwater stream systems and are known to inhabit about 257 km (160 mi) of refuge streams. Watersheds which provide the majority of spawning and nursery habitat for chinook salmon on the Kenai Refuge are the Kenai, Funny, Killey, Russian, Chickaloon, and Kasilof rivers (Alaska Department of Fish and Game 1993).

Adult chinook salmon enter refuge waters for spawning from late May through early August. Spawning occurs from mid-July through late August. Eggs overwinter in stream gravel and hatch in early spring. Fry emerge several days after hatching and begin feeding in the streams, where they may stay for up to two years before they make their seaward migration. Growth is rapid during ocean life, often exceeding 0.45 kg (1 lb) per month. Chinook salmon mature at ages ranging from three to seven years at which time they return to their natal streams to spawn.

Chinook salmon are highly prized by recreational anglers due to size, strength, and eating quality. The Kenai River supports a chinook salmon recreational fishery of worldwide fame. The river is reputed to support the largest chinook salmon in the world. The current world's record on hook and line was a 44 kg (97 lb) fish taken in the Kenai River in 1985.

Coho Salmon

Coho salmon use a wide range of freshwater habitats on the Kenai Refuge. They spawn or rear in at least 580 km (360 mi) of refuge streams (U.S.

Table 4.—Common and scientific names of fish species occurring on the Kenai National Wildlife Refuge, Alaska.

Scientific Name	Common Name
<i>Lampetra japonica</i>	Arctic lamprey
<i>Lampetra tridentata</i>	Pacific lamprey
<i>Oncorhynchus gorbuscha</i>	pink salmon
<i>Oncorhynchus keta</i>	chum salmon
<i>Oncorhynchus kisutch</i>	coho salmon
<i>Oncorhynchus mykiss</i>	rainbow trout ^a
<i>Oncorhynchus nerka</i>	sockeye salmon ^b
<i>Oncorhynchus tshawytscha</i>	chinook salmon
<i>Prosopium cylindraceum</i>	round whitefish
<i>Salvelinus alpinus</i>	Arctic char
<i>Salvelinus malma</i>	Dolly Varden
<i>Salvelinus namaycush</i>	lake trout
<i>Thymallus arcticus</i>	Arctic grayling
<i>Thaleichthys pacificus</i>	eulachon
<i>Esox lucius</i>	northern pike
<i>Catostomus catostomus</i>	longnose sucker
<i>Gasterosteus aculeatus</i>	threespine stickleback
<i>Pungitius pungitius</i>	ninespine stickleback
<i>Cottus aleuticus</i>	coastrange sculpin
<i>Cottus cognatus</i>	slimy sculpin
<i>Platichthys stellatus</i>	starry flounder

^a Steelhead also occur on the refuge.

^b Kokanee also occur on the refuge.

Fish and Wildlife Service 1985). Juveniles rear in lakes or streams for two to three years before smolting and migrating to sea at a length of 8-15 cm (3-6 in). Major spawning and rearing areas include the Kenai, Killey, Funny, Moose, Russian, Swanson, Kasilof, Fox, and Chickaloon rivers (Booth 1990; Faurot and Palmer 1992; Alaska Department of Fish and Game 1993).

Coho salmon grow rapidly in the ocean and sexual maturity is attained after only one winter at sea. Adults usually weigh from 2 to 5 kg (5 to 12 lb) except for fish returning to the Kenai River which can weigh in excess of 7 kg (15 lb). Coho salmon provide an important late summer and fall recreational fishery in the Kenai and Swanson rivers. They are highly desirable to anglers because of their fighting and jumping ability.

Sockeye Salmon

Sockeye salmon use about 354 km (220 mi) of streams and 44,517 hectares (110,000 acres) of lakes on the Kenai Refuge for spawning and rearing (U.S. Fish and Wildlife Service 1985). Spawning generally occurs in streams that connect with lakes, although some populations spawn in lakes and a few in streams with no lake.

Juvenile sockeye salmon normally rear for one or two years in lakes before smolting and migrating to the sea, usually during May and June. After two to three years at sea they return as sexually mature adults averaging 1.4-3.6 kg (3-8 lb) in weight. Sockeye in the Kenai River may exceed 6.8 kg (15 lb).

The largest sockeye salmon populations on the refuge are found in the Kenai and Kasilof river systems (King et al. 1993). The Kenai River, including the Russian River and Hidden Lake systems, is the major producer of sockeye salmon in Cook Inlet. Kenai River sockeye salmon support both a major commercial fishery in Cook Inlet and the largest recreational sockeye fishery in Alaska (Marsh 1993; Ruesch and Fox 1994). This road-accessible sport fishery is nationally known and even attracts fishermen from foreign countries. The Kasilof River, including Tustumena Lake, historically has been the second largest producer of sockeye salmon in Cook Inlet (Ruesch and Fox 1994).

A number of lakes on the refuge support populations of non-anadromous sockeye salmon (kokanee). Hidden Lake provides the largest refuge sport fishery for this life-history form (Mills 1994).

Chum Salmon

Chum salmon are the least abundant species of salmon on the refuge. Small runs occur in the Fox and Martin rivers which enter Kachemak Bay (Faurot and Palmer 1992; Alaska Department of Fish and Game 1993).

Chum salmon enter refuge streams during July and August at an age of three or four years. They spawn in riffle and upwelling areas of

streams with medium-sized gravel (Hale 1981). Eggs develop in the gravel and fry emergence usually occurs in April and May. Fry develop for about one month in freshwater, then spend several months in an estuarine environment before entering the ocean.

Pink Salmon

The largest run of pink salmon on the refuge occurs in the Kenai River with much smaller runs in the Kasilof, Chickaloon, Swanson, and Fox rivers and Big Indian and Little Indian creeks (Alaska Department of Fish and Game 1993). An even-numbered year annual spawning pattern is characteristic of most upper Kenai Peninsula streams (Ruesch and Fox 1994), whereas an odd-numbered year spawning cycle occurs in the Fox River (Faurot and Palmer 1992).

Pink salmon fry migrate to sea when they emerge from the gravel, spend 14 to 16 months at sea, and return as sexually mature adults mostly in July and August. Adults generally do not migrate far upstream and in some areas spawning occurs in tidally influenced areas (Morrow 1980). They are the smallest of the Pacific salmon and usually weigh from 0.9 to 2.3 kg (2 to 5 lb). Pink salmon are popular because they take artificial lures aggressively and are easily caught. Commercially, pink salmon are usually the most abundant in even numbered years, but bring the lowest price per pound.

Rainbow Trout

Rainbow trout are found in all major refuge watersheds except those entering Kachemak Bay. Anadromous rainbow trout (steelhead) inhabit Crooked and Nikolai creeks in the Kasilof River watershed. Resident populations are more widespread and occur in both lake and stream environments. Lake populations are common but their presence is dependent upon suitable spawning gravels in inlet or outlet streams. Rainbow trout seldom exceed 51 cm (20 in) in length in the smaller lakes and streams, although rainbow trout in the Kenai River and anadromous forms attain a much larger size.

Locally, rainbow trout are of secondary interest to anglers when salmon are available, but they are the preferred resident species during other times. They support an important fishery in the heavily used Swanson River and Swan Lake canoe systems and the popularity of the trophy rainbow fishery on the upper Kenai River is growing at a rapid pace. A genetic strain of rainbow trout that originates from the Swanson River is used by the Alaska Department of Fish and Game (Department) for statewide stocking because of the vigor of this particular race.

Dolly Varden

The Dolly Varden is the most abundant species of char on the Kenai Refuge (U.S. Fish and Wildlife Service 1985). There are several life history forms including stream resident, stream spawning-lake resident

and anadromous populations. The stream resident form inhabits a substantial portion of the 2,400 km (1,500 mi) of refuge streams.

Dolly Varden vary in size but most individuals are small, less than 38 cm (15 in) long. A good-sized fish is 48-51 cm (19-20 in) long and weighs 1.1-1.4 kg (2.5-3 lb). Dolly Varden, like other char, are fall spawners utilizing streams with gravel bottoms (Morrow 1980).

Anadromous populations generally spend three to four years in freshwater before smolting (Morrow 1980). The smolts spend only a few weeks to several months at sea before returning to freshwater for spawning and overwintering. Several anadromous runs occur on the refuge but none have been well studied. Anadromous runs are present in the Kenai, Kasilof, and Fox rivers and may occur elsewhere as well.

Lake resident Dolly Varden are common in Tustumena and Skilak lakes where they provide a sport fishery (Mills 1994). Fish up to 2.3 kg (5 lb) are taken annually from the Kenai River inlet into Skilak Lake. Dolly Varden occur in several smaller refuge lakes but generally are not abundant.

Dolly Varden are important to anglers when salmon are not available. They are often common near the mouths of lakes in the spring and in rivers during their fall migration. In the Kenai River, the sport fishery for Dolly Varden appears to be growing at a rate similar to that observed for rainbow trout. Both species are readily caught using similar angling techniques.

Arctic Char

Of the three char species found on the refuge (lake trout, Dolly Varden, and Arctic char), the Arctic char is probably the least abundant. Arctic char are lake spawners that have been reported from nearly 50 refuge lakes in the Swanson River watershed (U.S. Fish and Wildlife Service, unpublished data). Externally, Dolly Varden and Arctic char are nearly impossible to differentiate and can be separated only by internal examination. Because of the difficulty in distinguishing these two species, distribution records for the refuge may not be accurate. Some fishery biologists on the Kenai Peninsula have lumped both species together. Where positive identifications have been made, both species have occasionally been found using the same refuge lakes.

Arctic char are a moderate-sized species on the refuge with most individuals less than 51 cm (20 in) long. Because of their preference for cold, deep water they are generally unavailable to anglers during the summer months but do contribute to the spring, fall, and winter recreational fisheries.

Lake Trout

Lake trout occur in Hidden, Skilak, and Tustumena lakes, the three largest lakes on the refuge (U.S. Fish and Wildlife Service 1985). They

spawn in the fall over rocky lake bottoms. This species is long lived with sexual maturity not usually occurring until seven years of age. Lake trout can attain large size but 2.3-4.5 kg (5-10 lb) is a good sized fish on the Kenai Peninsula. Hidden Lake provides the best lake trout sport fishery on the Kenai Peninsula (Mills 1994). Fishing occurs in the summer and during a winter ice fishery.

Longnose Sucker

Longnose suckers are common on the northern portion of the Kenai Lowlands. They are abundant in a number of lakes in the Moose, Swanson, and Chickaloon river drainages. They have not been reported in the Kasilof River watershed and do not occur in lakes of smaller watersheds draining into Cook Inlet such as Miller, Bedlam, and Pincher creeks. Longnose suckers generally attain a length of 41-51 cm (16-20 in), however, a dwarf form occurs in the Finger Lakes which does not exceed 30.5 cm (12 in) in length.

Longnose suckers spawn in the early summer, usually in streams, and become concentrated at times in some locations where they may be an important seasonal food source for bald eagles and possibly otters and mink. This species is long lived. Individuals have been aged up to 19 years suggesting low natural mortality rates.

Round Whitefish

The round whitefish is the only member of the whitefish subfamily found on the Kenai Peninsula. Available information suggests that the distribution of this species is rather limited. They are mostly confined to the larger lakes such as Skilak and Tustumena and the larger rivers. Scenic and Camp Island lakes are the only lowland lakes on the refuge known to support this species. A few are caught incidentally each year but otherwise the species is of little interest to anglers.

Pacific Lamprey

Pacific lamprey have been observed spawning in the Moose River during June. The young reportedly spend four years in the river bottom as filter feeding ammocoetes before migrating to sea for a year as a parasite of larger fish such as salmon. Adults return in the fall, overwinter in fresh water without feeding, then spawn and die the following summer. The spawning adults are easily seen and approached and may serve as food for some wildlife species.

Arctic Lamprey

Arctic lampreys are common during their June spawning season in the Moose River and have been collected in small numbers in the Swanson and Chickaloon river basins and in the Finger Lakes. This species is believed to be a non-parasitic freshwater resident on the refuge. Freshwater Arctic lamprey are small and rarely exceed 18 cm (7 in) in length (Morrow 1980).

Arctic Grayling

Arctic grayling are distributed throughout much of Alaska but did not occur naturally on the Kenai Refuge. Arctic grayling were stocked into Twin Lakes in 1965 and into Lower Fuller Lake in 1967 by the Department. Arctic grayling in Twin Lakes came from Crescent Lake, on the Chugach National Forest, while the Lower Fuller Lake stock came from Tonsino Lake near Glenallen. Arctic grayling are popular with anglers but provide limited sport fishing on the refuge because Lower Fuller Lake is only 5 hectares (12 acres) in size and Twin Lakes are accessible only by float-equipped aircraft. Both populations are maintaining themselves through natural reproduction.

Threespine Stickleback

The threespine stickleback is the most abundant resident freshwater species on the Kenai Refuge. This small fish, seldom exceeding 6.4 cm (2.5 in) in length, is present in nearly every lake on the Kenai Lowlands and is usually abundant. Females spawn during the summer in nests made and guarded by the male. Sexual maturity is attained at age 1 but their life span is only 25-27 months. Threespine stickleback provide forage for rainbow trout, coho salmon, and char, but they also compete with juvenile salmonids for food and space. They are frequently the only fish species found in lakes used by fish eating birds such as common and Arctic loons, red-necked grebes, Arctic terns, and Bonapart's and mew gulls.

Anadromous populations of threespine stickleback occur in the Chickaloon, Swanson, Killey, Moose, and Fox rivers. The anadromous form is distinguished from the resident form by an enlarged ventral keel and their larger size. Anadromous threespine stickleback attain lengths of 8.9 cm (3.5 in).

Ninespine Stickleback

Ninespine stickleback also occur on the refuge although not in large numbers. They are primarily found in oxbow ponds connected to small rivers such as the Moose and Chickaloon. This species probably provides forage for predaceous fishes and fish eating birds. Ninespine stickleback are small and seldom exceed 7.6 cm (3 in) in length.

Slimy Sculpin

The slimy sculpin is commonly found in most refuge lakes and streams. Most slimy sculpins are less than 12.7 cm (5 in) in length and probably provide food for larger fishes and fish eating birds and mammals.

Coastrange Sculpin

The other sculpin found on the refuge is the coastrange sculpin. This sculpin is normally more abundant near the coast and not well represented inland. It is the most abundant sculpin found in lakes of

the Swanson River drainage. Elsewhere on the refuge it is usually inferior in numbers to the slimy sculpin (U.S. Fish and Wildlife Service, unpublished data).

Northern Pike

Northern pike are distributed throughout much of Alaska but did not occur naturally on the Kenai Peninsula. They were introduced into Mackey Lakes in the Soldotna Creek watershed by a private citizen during the mid 1970's. There are reports of northern pike in Cisca, Tree, and Gagara lakes which are located near the refuge boundary in the upper Soldotna Creek drainage, but these reports have not been substantiated. In 1986, a northern pike was observed by Service personnel in the Moose River above the refuge boundary (Booth In Preparation). This sighting indicates that northern pike have migrated up the Kenai River or that another illegal introduction has occurred. No evidence of successful reproduction has been documented in the Moose River, however, if northern pike become established in this watershed, declines in rainbow trout and other species can be expected.

Watershed Descriptions

Watersheds on the Kenai Refuge drain into Cook Inlet, Turnagain Arm, and Kachemak Bay. Physical characteristics of each watershed and water quality are described as available. Information on the distribution, status, and dynamics of refuge fish populations occurring in each watershed is also provided. The Kenai River, the largest watershed, is discussed first followed by its tributary watersheds. Other watersheds entering Cook Inlet, Turnagain Arm, and Kachemak Bay are then described.

Kenai River

The Kenai River is a glacially fed river which originates from Kenai Lake 132 km (82 mi) from saltwater (Figure 2). Approximately 27 km (17 mi) below Kenai Lake, the river traverses Skilak Lake and flows 80 km (50 mi) to Cook Inlet. Discharge in the Kenai River is dependent on the outflow of Kenai and Skilak lakes and lacks the flow extremes characteristic of streams without glacial lakes at their headwaters. The mean annual discharge in the Kenai River is approximately 142 m³/s (5,000 ft³/s) with peak discharges of 566-850 m³/s (20,000-30,000 ft³/s) occurring in late summer (Scott 1982). Although glacial melt produces turbid conditions throughout the year, water clarity increases during low-flow conditions (November through May).

The Kenai River system provides spawning and rearing habitat for several species of salmon and trout. Chinook, coho, sockeye, and pink salmon are seasonally abundant in the drainage. Pink salmon occur predominantly during even numbered years, but small numbers are also present during odd numbered years.

Other salmonids that occur in the Kenai River drainage include rainbow and lake trout, and Dolly Varden. Rainbow trout appear to be stream

residents rather than the anadromous form. Lake trout reside in Skilak and Kenai lakes, whereas Dolly Varden occur throughout the Kenai drainage. Both resident and anadromous forms of Dolly Varden occur in the Kenai River.

Chinook salmon return to the Kenai River as two distinct runs. An early run typically enters the river from mid-May until late June and spawns from mid to late July in tributary streams such as the Killey and Funny Rivers. The late run typically enters the river in July and early August and spawns primarily in the mainstem Kenai River from mid to late August. The Department operates a sonar site in the lower Kenai River to monitor escapement of both early and late-run fish. Optimum escapement goals are 9,000 fish for the early run and 22,300 for the late run. If projected escapement levels fall short of these goals, restrictions are placed on the recreational and commercial fisheries. Annual escapement of chinook salmon in the Kenai River from 1985 through 1994 has ranged from 7,756-19,227 for early-run fish and from 19,581-48,037 for late-run fish (Nelson et al. *In Press*).

Chinook salmon returning to the Kenai River support one of the most popular sport fisheries in Alaska. This May, June, and July sport fishery was first estimated at 23,610 angler days in 1974, but has increased to nearly 110,000 angler days in 1994 (Nelson et al. *In Press*). Annual sport harvest of chinook salmon has increased from 4,910 in 1974 to 20,022 in 1994. The large physical size of chinook salmon in the Kenai River contributes to the popularity of this fishery.

Like chinook salmon, the coho salmon return to the Kenai River is comprised of early and late-run fish. Early-run coho salmon generally enter the Kenai River in August and spawn in tributaries of the Kenai River during September and October (Booth 1990). The majority of late-run fish enter the Kenai River during September and spawn in the mainstem Kenai River from October through March.

The coho salmon return to the Kenai River is one of the State's most popular sport fisheries. Annual sport harvest of coho salmon has averaged nearly 54,000 fish from 1985 through 1993 with over 76,000 fish harvested in 1991 (Mills 1986-1994). Coho salmon returning to the Kenai River also contributed an estimated 7,512 fish to the Cook Inlet commercial fishery during 1993 (Carlson and Hasbrouck 1994).

Existing management of coho salmon in the Kenai River is based on catch per unit effort data of commercial and sport fisheries as compared with historical averages. This has been effective in maintaining stocks, however, it is unclear whether optimum production is being achieved. The Department is addressing this concern and has initiated studies to enumerate coho salmon entering the Kenai River.

Sockeye salmon also return to the Kenai River as two distinct runs. The early run typically enters the Kenai River in early June and migrates to the Russian and Kenai river confluence where they remain for approximately two weeks before continuing their migration up the Russian

River. Late-run sockeye salmon enter the Kenai River in mid-July and spawn in the mainstem Kenai River and tributary streams.

The escapement of sockeye salmon into the Kenai River has been estimated by the Department with side-scanning sonar since 1968. Since then, annual escapements have averaged 530,000 fish with escapements of over one million fish occurring in 1987, 1988, 1989, and 1994 (Ruesch and Fox 1994; Nelson et al *In Press*). These fish provide a valuable resource to commercial fishermen in Cook Inlet and to recreational anglers on the Kenai and Russian rivers.

The annual sport harvest of sockeye salmon in the Kenai River has increased substantially since the mid-1980's. Between 1977 and 1986, the annual sport harvest averaged about 38,000 fish. In 1987, 1.6 million sockeye salmon entered the Kenai River which led anglers to discovering more effective techniques for catching these fish. From 1987 through 1994, the annual harvest of sockeye salmon has averaged 185,000 fish (Nelson et al. *In Press*).

Although chinook, coho, and sockeye salmon are the most frequently targeted species by user groups, pink salmon are also an important resource of the Kenai River. Kenai River stocks of pink salmon are harvested by both sport and commercial fishermen. Sport catch and harvest of pink salmon is highest during even-numbered years. Mills (1993) reported that in 1992, over 74,000 pink salmon were caught and approximately 10,000 were harvested in the Kenai River. Kenai River pink salmon also are harvested commercially in the Central District East Side set net fishery. Even-year harvest in this fishery has averaged over 400,000 fish from 1966 to 1992 (Ruesch and Fox 1994).

The most popular resident fish species in the Kenai River are rainbow trout and Dolly Varden. Both species are caught throughout the river, but the most popular fishing areas are on or adjacent the refuge above and below Skilak Lake. Lafferty (1989) described the rainbow trout populations above and below Skilak Lake as discrete populations. The population above Skilak Lake contains large numbers of rainbow trout over 20 inches and is currently managed as a trophy rainbow trout fishery. The rainbow trout population below Skilak Lake contains fewer numbers of rainbow trout over 20 inches and experiences a higher rate of exploitation.

The popularity of the sport fishery directed at these two species has increased dramatically in recent years. The number of rainbow trout caught above Skilak Lake increased from 11,995 in 1990 to 37,755 in 1993 (Mills 1991-1994). Similarly, the number of Dolly Varden caught in this section of river increased from 14,151 in 1990 to 36,451 in 1993. Fewer rainbow trout and Dolly Varden are caught in the middle Kenai River between the Moose River and Skilak Lake, however, the upward trend in the number of fish being caught is similar to that observed above Skilak Lake. Most anglers practice catch and release fishing for these species. In 1993, anglers harvested approximately 8.4% of the Dolly Varden and 0.5% of the rainbow trout which were caught above Skilak Lake

(Mills 1994). Harvest rates between the Moose River and Skilak Lake were higher at 16.9% for Dolly Varden and 5.2% for rainbow trout.

Other species utilizing the Kenai River and its tributaries include lake trout, round whitefish, longnose sucker, Pacific and Arctic lampreys, threespine and ninespine stickleback, slimy and coastrange sculpin, and eulachon. Two exotic species have been introduced into the watershed. Northern pike occur in several lakes near Soldotna and have been observed in the Moose River (Booth In preparation). Arctic grayling were introduced into Twin Lakes and Lower Fuller Lake by the Department.

Beaver Creek

Beaver Creek drains 121 km² (47 mi²) of wetland and lowland forest habitat into the Kenai River near river kilometer 16 (river mile 10) (Figure 2). The refuge portion of the watershed encompasses 70% percent of the watershed and contains four named lakes. Two of the three lakes that have been surveyed contain rainbow trout populations. Beaver Creek is an important rearing area for coho salmon (Elliot and Finn 1984). Chinook and sockeye salmon juveniles also rear in the creek but in much lower numbers. Beaver Creek also provides rearing habitat for Arctic and Pacific lamprey, rainbow trout, Dolly Varden, threespine and ninespine stickleback, slimy and coastrange sculpin, and round whitefish.

Elliot and Finn's (1984) investigation of Beaver Creek examined fish species composition and distribution, spawning and rearing habitats, stream discharge, and various water quality parameters. This baseline information was needed to ensure adequate protection against expanding urban development and industrial activities. Marathon Oil Company operates several oil and gas wells in the Beaver Creek watershed.

Slikok Creek

Slikok Creek drains 96 km² (37 mi²) of wetland and lowland forest habitat into the Kenai River at river kilometer 30 (river mile 19) (Figure 2). Slikok Creek provides spawning and rearing habitat for coho and chinook salmon (Elliot and Finn 1984). Other species found in the watershed include sockeye salmon, rainbow trout, Dolly Varden, Arctic and Pacific lamprey, ninespine and threespine stickleback, and coastrange and slimy sculpin. Four lakes in the watershed are on the Kenai Refuge. Three of the lakes have been surveyed but none support sport fish populations. A borough sanitary land fill is located in the watershed near the refuge boundary.

Funny River

The Funny River begins as a small stream at an elevation of 1,128 m (3,700 ft) in the Kenai Mountains and flows 51 km (32 mi) to join the Kenai River at river kilometer 49 (river mile 30.5) (Figure 2). The watershed covers an area of 329 km² (127 mi²). There are no glaciers in

the basin and its waters are bog stained. The river contains substantial amounts of spawning gravel.

Studies conducted by Burger et al. (1983) indicated that the Funny River is an important spawning area for early-run chinook salmon. Six of 60 early-run chinook salmon radio-tagged in the Kenai River during 1980 and 1981 were tracked to the Funny River. Spawning times were estimated to extend over a 5-week period with a peak between July 15 and July 26.

Coho and pink salmon also spawn in the Funny River but no effort has been made to determine run size or timing. Rainbow trout and Dolly Varden are also present and apparently support some sport fishing activity.

Access to the lower section of river is provided by the Funny River Road. Most of the watershed (80%) is in designated Wilderness where access is poor.

Moose River

The Moose River is the largest tributary to the Kenai River and is characterized by slow flow, extensive submergent aquatic vegetation, and bog stained water (Figure 2). The watershed consists of 648 km² (250 mi²) of lowland habitat and contains 188 km (117 mi) of streams, 60 named lakes, and over 200 unnamed lakes and ponds.

The Moose River watershed supports 16 species of fish including four species of Pacific salmon, rainbow trout, Dolly Varden, round whitefish, threespine and ninespine stickleback, coastrange and slimy sculpin, Pacific and Arctic lamprey, longnose sucker, eulachon, and northern pike. The Service operated a counting weir on the Moose River during 1985 and 1986 (Booth In preparation). Escapement of early-run sockeye salmon numbered 690 in 1985 and 2,071 in 1986. Early-run sockeye salmon migrated upstream in June and July and spawned in the Moose River. A late run of sockeye salmon entered the river in July and August and spawned in headwater lakes; they numbered 2,088 in 1985 and 847 in 1986. Coho salmon entered the Moose River beginning in August and continued through early October. Escapement of coho salmon in the Moose River numbered 1,657 in 1985 and 3,969 in 1986. Only two chinook salmon were counted at the weir in 1985. A total of 13 pink salmon were observed at the weir in 1985 and four were counted in 1986. Rainbow trout were found throughout the watershed and spawned in the mainstem Moose River as well as the East and West Forks of the Moose River in May and early June. A northern pike was observed at the weir in 1986. This fish was not captured but weighed an estimated 1.8 kg (4 lb). No evidence of successful spawning by northern pike was detected during the 1985-1986 survey.

Killey River

The Killey River is a glacial river draining 554 km² (214 mi²) of the western slope of the Kenai Mountains into the Kenai River at river

kilometer 71 (river mile 44)(Figure 2). The largest tributary is Benjamin Creek, a clear water stream which enters the Killey River 53 river kilometers (33 river miles) from its confluence with the Kenai River. The majority of the watershed (99%) is within the Kenai Refuge.

The Killey River provides spawning and rearing habitat for chinook salmon and other species of salmonids. Radiotelemetry studies conducted in the Kenai River by Burger et al. (1983) during 1980 and 1981 showed that the Killey River was the major spawning destination for early-run chinook salmon. Seventy-five percent of the fish radio-tagged during May and June returned to the Killey River to spawn. Burger et al. (1983) set up an electronic barrier and a weir near the mouth of the river in 1981 to enumerate the chinook salmon run in the Killey River. The spawning population was estimated at 8,118 salmon. Benjamin Creek, near its confluence with the Killey River, is a major spawning area for chinook salmon in this drainage. This location is an important feeding area for brown bears on the refuge between Skilak and Tustumena lakes.

Little information is available about other species in this watershed. Two of the seven lakes in the watershed have been inventoried. Twin Lakes supports Arctic grayling which were introduced by the Department in 1965. Coho and pink salmon also spawn in the Killey River but the extent is unknown. The lower river is accessible by boat but high summer flows, mountain gradients, and sweepers make the upper and middle sections nearly inaccessible to power boats or rafts.

King County Creek

This mountain stream is 18 km (11 mi) long and drains 36 km² (14 mi²) of mountainous forests north into Skilak Lake (Figure 2). Sockeye and coho salmon spawn in the lower 2.4 km (1.5 mi) of the creek. Little is known about other fish populations using this stream or three smaller, but similar, mountain streams to the east which also drain into Skilak Lake.

Hidden Creek

Hidden Creek flows into Skilak Lake near the Kenai River inlet and is the outlet stream for Hidden Lake (Figure 2). Hidden Lake is the third largest lake on the Kenai Refuge with a surface area of 683 hectares (1,687 acres), a mean depth of 20.2 m (66.2 ft), and a volume of 138.1 x 10⁶m³ (112,000 acre ft). Lake water residence time is approximately 11.7 years (Kyle et al. 1990).

The Hidden Creek watershed supports spawning and rearing populations of sockeye and coho salmon and resident populations of lake trout, rainbow trout, Dolly Varden, threespine stickleback, and coastrange sculpin. Chinook and pink salmon have also been reported in the system (Kyle et al. 1990). Hidden Lake supports the most popular lake trout fishery on the Kenai Peninsula (Mills 1994) and a popular winter ice fishery.

The Department initiated a sockeye salmon enhancement project on Hidden Lake in 1976 to help rebuild depressed sockeye salmon stocks in Cook

Inlet. Enhancement efforts have continued since then and include egg takes, hatchery incubation (Trail Lakes Hatchery), stocking, and limnological studies (Kyle et al 1990). The Department conducted all enhancement efforts on Hidden Lake until 1988 when Cook Inlet Aquaculture Association assumed responsibility for enhancement activities. A weir and smolt trap are operated annually on Hidden Creek to enumerate and sample returning adults and outmigrating smolts.

The authorized stocking level for Hidden Lake is approximately 2 million unfed or 1 million fed fry. These stocking levels produce an adult return of about 30,000 fish; a return that will safely allow continued enhancement of Hidden Lake without jeopardizing lake water quality and resident species. The Department exceeded these stocking levels during 1987 and 1988 when approximately 3.7 and 6.1 million fry, respectively, were released into Hidden Lake. Adult returns resulting from these stocking levels totaled 77,959 in 1990 and 112,792 in 1991. The large escapement in 1990 did not alter the water quality of Hidden Lake substantially (Fandrei 1991). A dip net fishery was administered by the Service and Department to limit the number of spawners entering Hidden Lake in 1991. There should be no need to control excess escapement into Hidden Lake in future years.

Engineer Lake is the second largest lake in the Hidden Creek drainage with a surface area of 93 hectares (230 acres). Fish species present include coho salmon, Dolly Varden, rainbow trout, threespine stickleback, and coastrange sculpin. The Department stocked Engineer Lake with coho salmon from 1975 through 1992 which resulted in a popular put-grow-and-take fishery. Stocking was discontinued in 1992 because of concerns that hatchery coho salmon released in Engineer Lake could be entering Hidden Lake through the outlet connecting the two lakes and mixing with wild anadromous stocks.

Skilak River

The Skilak River drains a 433 km² (167 mi²) watershed into the east end of Skilak Lake (Figure 2). The Harding Icefield covers over half (51%) of the watershed resulting in runoff that is extremely glacial. The lower 8 km (5 mi) of river flow in a braided channel. Ice dams form occasionally in this drainage resulting in sudden flooding when the dams are breached.

The Skilak River probably does not support any substantial fish populations due to extreme glacial conditions. Anadromous fish are not known to use the Skilak River or any of its tributaries for spawning. The resident fish population remains unknown. Pothole Lake, the only named lake in this watershed, has not been surveyed.

Jean Creek

This small watershed drains 34 km² (13 mi²) of forest and wetland habitats adjacent to the Sterling Highway and Skilak Lake Road (Figure 2). Jean Lake and Upper Jean Lake are road accessible lakes in the

watershed having surface areas of 47 hectares (115 acres) and 20 hectares (50 acres), respectively.

Upper Jean Lake supports native populations of threespine stickleback and slimy sculpin. The lake is landlocked and has no tributary streams to provide spawning habitat for salmonid populations. From 1962 to 1983, the Department stocked rainbow trout, coho, and sockeye salmon in various years to provide a sport fishery. The lake supported a very popular sport fishery but stocking was terminated due to concerns regarding safe entry from the Sterling Highway. Safety concerns could be alleviated by developing a parking area and trail access to the lake. A put, grow, and take fishery could be reestablished in Upper Jean Lake if access is improved.

The remainder of the watershed provides rearing habitat for coho and sockeye salmon. Resident species include rainbow trout, Dolly Varden, threespine stickleback, and slimy sculpin. Jean Lake has a boat launching ramp and a small campground. This attractive lake is readily accessible from the Sterling Highway but few anglers have been observed on the lake.

Russian River

The Russian River is a clearwater stream which drains a 163 km² (63 mi²) mountainous watershed (Figure 2). The drainage includes two large clearwater lakes, Upper and Lower Russian lakes, and terminates in the Kenai River approximately midway between Kenai and Skilak lakes. Half of the watershed is on refuge lands, the other half is on the Chugach National Forest.

The Russian River watershed supports spawning and rearing populations of sockeye, coho, and chinook salmon and resident populations of rainbow trout and Dolly Varden. This watershed supports very popular sport fisheries for rainbow trout and sockeye salmon. The largest recreational fishery for sockeye salmon in Alaska occurs in the Russian River and at its confluence with the Kenai River. Annual effort by anglers in this fishery has exceeded 450,000 angler-hours and annual harvests have exceeded 190,000 fish (Carlson et al. 1991).

There are two runs of sockeye salmon in the Russian River. The early run usually arrives by June 15 and is managed exclusively for sport fishing while the second run peaks in July and is managed for both commercial and sport harvest. The Department operates a weir at the outlet of Lower Russian Lake to monitor escapement and manage the recreational fishery. Current escapement goals in the Russian River are 16,000 fish for the early run and 30,000 fish for the late run (Vincent-Lang and Carlson 1991). Annual spawning escapements often exceed goals and have averaged 23,020 early-run fish and 55,510 late-run fish from 1963-1994 (Nelson et al. *In Press*).

The Russian River falls, located approximately two miles upriver from the Russian-Kenai River confluence, provides a popular area for visitors

to view returning sockeye salmon. The falls also present a major obstacle to migrating salmon during higher discharges. To improve fish passage during higher discharges, a fish by-pass was constructed around the falls in 1978 by the Department. The fish by-pass is typically operated when discharges exceed $11.3 \text{ m}^3/\text{s}$ ($400 \text{ ft}^3/\text{s}$) and has passed as many as 500 sockeye salmon per hour.

Kasilof River

The Kasilof River drains a watershed of $2,150 \text{ km}^2$ (830 mi^2) making it the second largest watershed on the refuge (Figure 2). The watershed consists of mountains, glaciers, forests, and the Kenai Peninsula's largest lake, Tustumena. The Kasilof River is only 29 km (18 mi) long and drains Tustumena Lake which has a surface area of 29,450 hectares (72,710 acres), a maximum depth of 287 m (942 ft) and a mean depth of 124 m (407 ft). All tributary streams in the watershed which drain refuge lands enter Tustumena Lake except Crooked Creek which enters the Kasilof River at river kilometer 10 (river mile 6).

The Kasilof River watershed supports several species of anadromous and resident fish including coho, sockeye, chinook, and pink salmon, rainbow trout, Dolly Varden, lake trout, round whitefish, threespine stickleback, and coastrange and slimy sculpin. Dolly Varden and lake trout were the most frequently caught species in gill nets during a Tustumena Lake resident fish investigation in 1987 (Jones and Faurot 1991). Species caught most frequently in minnow traps were Dolly Varden and coastrange sculpin. During the same year, the Service examined run timing and spawning distribution of coho and late-run chinook salmon in the watershed (Faurot and Jones 1990). Coho salmon returns to Tustumena Lake tributaries were low in 1987, but spawning fish were observed at Indian, Pipe, Glacier Flats, and Seepage creeks. Late-run chinook salmon entered the Kasilof River during July and spawned primarily at two mainstem locations below Tustumena Lake.

Late-run chinook salmon in the Kasilof River have been used as a broodstock for developing recreational fisheries near Homer and Seward. The Department has collected eggs from approximately 40 females each year through 1994 to develop these fisheries. These fisheries should be sufficiently developed by 1995, at which time broodstock will be collected at Seward or Homer rather than from the Kasilof River.

The Kasilof River watershed supports the only known populations of anadromous rainbow trout (steelhead) on the refuge. Nikolai Creek, a Tustumena Lake tributary, supports a small run of steelhead. Crooked Creek supports a larger run of steelhead which was enhanced with fish produced by the Department at the Crooked Creek Hatchery from 1984 through 1993. Enhancement efforts increased annual escapements in Crooked Creek from less than 100 fish prior to 1984 to 2,960 fish in 1993. All steelhead in excess of needs for the annual egg take (approximately 30-40 adults) were passed above the weir located at the hatchery and allowed to spawn (Och 1991). This enhancement program was terminated in 1993 because of concern that these hatchery fish would

stray into the Kenai River and negatively impact wild stocks. Future returns are expected to gradually decline to abundance levels which were observed prior to enhancement.

Crooked Creek also supports populations of Dolly Varden, chinook, and coho salmon. Chinook and coho salmon in Crooked Creek have been used as broodstock to develop sport fisheries in the Kasilof River and other Kenai Peninsula waters. Broodstocks of both species are collected at the Crooked Creek Hatchery which is owned by the State of Alaska and currently operated by Cook Inlet Aquaculture Association. Chinook salmon smolts are produced at Elmendorf Hatchery and have been stocked in Crooked Creek since 1975. Coho salmon smolts have been produced at Crooked Creek Hatchery since 1983, however, this enhancement program was terminated in 1994 because of budgetary constraints. From 1986-1993 these enhancement programs have resulted in average annual returns of 8,347 chinook and 5,197 coho salmon (Nelson et al In Press). During the same period, annual sport harvest in the Kasilof River and Crooked Creek averaged 5,491 chinook and 3,834 coho salmon. Crooked Creek escapement goals (above the hatchery weir) for chinook and coho salmon are 750 and 1,250 fish, respectively. All Dolly Varden migrating upstream are also passed over the weir and allowed to spawn or overwinter.

The Crooked Creek Hatchery also supports a sockeye salmon enhancement project which was initiated on Tustumena Lake in 1976 by the Department. Enhancement efforts have been experimental since then and include egg takes, hatchery rearing, stocking, hydroacoustic surveys, smolt enumeration, and limnological studies. The lake has been stocked nearly every year since 1976 to augment natural production. The stocking rate has been as high as 17 million fry, however, 6 million fry have been stocked annually in recent years. The eggs for stocking have been taken from Bear and Glacier Flats creeks, two streams entering Tustumena Lake, and incubated at the Crooked Creek Hatchery. The enhancement program has increased sockeye salmon production in the watershed and yield to the commercial and recreational fisheries. The current escapement goal in the Kasilof River is 150,000-250,000 sockeye salmon. An average of 207,000 fish have been counted annually at the Department's sonar site since 1976 (Ruesch and Fox 1994).

The stocking program in Tustumena Lake has become a controversial issue. Concerns have been expressed about: 1) the appropriateness of stocking a lake which lies in a Wilderness Area; 2) the potential for increased incidental harvest of chinook and coho salmon bound for the Kenai and Kasilof rivers by the east side set net fishery; 3) harmful long term genetic effects caused by selection pressures resulting from eggs being hatched and reared in an artificial environment; and 4) overharvest of naturally reared salmon in a mixed stock fishery. There are also concerns that stocking may have a potential impact on the resident freshwater fish populations in Tustumena Lake. Operational status of the program will be determined through the National Environmental Policy Act (NEPA) process.

Swanson River

The Swanson River watershed covers approximately 717 km² (277 mi²) and is located in the northwest portion of the Kenai Refuge (Figure 2). It originates in the Swanson Lakes area west of the Chickaloon River drainage and empties into Cook Inlet. The Swanson River watershed includes approximately 134 km of streams, 125 named lakes, and a large number of other unnamed lakes and ponds. It contains more lakes than any other watershed on the Kenai Refuge.

Four species of salmon occur in the Swanson River watershed. A few pink salmon spawn in the lower section of river. Sockeye and chinook salmon are also present, but coho salmon is the most abundant species. The Department operated a salmon counting weir on the Swanson River from 1962 to 1967 (Engle 1968). Coho salmon escapement estimates ranged from 239 to 2,043, but these estimates are considered low because the weir was operated for varying lengths of time each year and portions of the run were missed during some years. Larger escapements were observed in the Swanson River during 1988 and 1989 when the Service operated a weir on this river (Jones et al. 1993). In 1988, 23,514 coho, 1,542 sockeye, 72 pink, and 5 chinook salmon passed through the weir between May 21 and September 26. In 1989, only coho salmon were monitored with 20,841 fish counted from July 30 to August 27 when weir operations were suspended due to heavy rain and high water levels.

Rainbow trout is the most abundant and widely distributed resident sport fish species in the Swanson River watershed. This species is found in headwater lakes, tributary streams, and in the mainstem river. In 1988 and 1989, the Service examined the migration timing and spawning distribution of rainbow trout in the watershed (Jones et al. In preparation). Fish typically reside in headwater lakes and enter tributary streams and the mainstem river from late April to mid-June to spawn. The largest concentrations of spawning fish were observed in the mainstem river and Sucker Creek.

Other resident species found in the Swanson River watershed include longnose sucker, Dolly Varden, Arctic char, threespine stickleback, ninespine stickleback, Arctic lamprey, and slimy and coastrange sculpin. Unlike most other refuge watersheds, the coastrange sculpin is more common in the Swanson River drainage than the slimy sculpin. Arctic char have been reported from nearly 50 lakes in this watershed.

The Swanson River, with its tributaries and lakes, is the second most popular watershed on the Kenai Refuge. Opportunities for fishing, hunting, canoeing, and camping in a wilderness setting cause the Swanson River watershed to receive extensive public use. Primary areas of use are the Swan Lake (partially in the Swanson River watershed) and Swanson River Canoe Routes which are National Recreation Trails and connect more than 50 headwater lakes with each other and with 75 km (47 mi) of the Swanson River.

Rainbow trout and coho salmon are the most popular sport fish species in the Swanson River drainage. Mills (1994) estimated that 5,150 angler days of effort were expended in the Swanson River and Swan Lake Canoe Routes during 1993, with an estimated catch of 14,818 rainbow trout. An additional 5,690 angler days of effort occurred on the Swanson River resulting in an estimated catch of 4,888 coho salmon and 2,431 rainbow trout. Approximately 71% of the coho salmon caught were harvested and only 21% of the rainbow trout were harvested. Shiffer (1989) reported a similar harvest rate (25%) for rainbow trout in 1988.

Seven Egg Creek

Seven Egg Creek drains 109 km² (42 mi²) of forested habitat on the Kenai Lowlands into Cook Inlet (Figure 2). Five of the nine named lakes in the watershed have been surveyed. Three of the lakes support populations of rainbow trout (U.S. Fish and Wildlife Service, unpublished data). The only other resident fish species reported in this watershed is threespine stickleback. The lower 8.8 km (5.5 mi) of Seven Egg Creek provide spawning and rearing habitat for coho salmon (Alaska Department of Fish and Game 1993).

A 15.5 km² (6 mi²) portion of the lower watershed is outside the refuge boundaries. This land was sold by the Kenai Peninsula Borough in 1984 to private individuals for homesites. This watershed will probably experience increased use as the area develops and access improves.

Otter Creek

Otter Creek drains 52 km² (20 mi²) of lowland forest habitat into Cook Inlet (Figure 2). The creek supports anadromous populations of coho salmon and Dolly Varden (Alaska Department of Fish and Game 1993). There are no named lakes in this watershed. The lower 9% of this watershed outside the refuge is part of the Gray Cliffs subdivision. This land was sold by the Kenai Peninsula Borough in the early 1980's to private individuals for homesites. Like Seven Egg Creek, this watershed will probably experience increased use as the area develops and access improves.

Scaup Creek

This watershed drains 49 km² (19 mi²) of lowland forest into Cook Inlet (Figure 2). Scaup Lake is the only named lake in the watershed. Neither the lake nor the stream have been surveyed. Anadromous fish have not been reported in Scaup Creek. Rainbow trout may occur in this watershed, but this has not been verified. The lower portion of this creek drains part of the Gray Cliffs Subdivision which is off-refuge.

Miller Creek

This small watershed of 28 km² (11 mi²) drains a lowland forested portion of the Kenai Refuge into Cook Inlet (Figure 2). Sixty-nine percent of the watershed is on the refuge. Three of the four named

lakes in the watershed have been surveyed. Rainbow trout have been found in every lake sampled, but little is known of fish populations occurring in Miller Creek itself (U.S. Fish and Wildlife Service, unpublished data).

Chickaloon River

The Chickaloon River is the third largest watershed on the Kenai Refuge. The river drains 798 km² (308 mi²) along the western slope of the Kenai Mountains and a portion of the Kenai Lowlands into Turnagain Arm (Figure 2). Access is difficult in this watershed. As a result, not much was known about its fishery resources until 1984 when an investigation was initiated by the Service.

The Chickaloon River supports populations of pink, chinook, sockeye, and coho salmon. Pink salmon escapement in the Chickaloon River during 1984 was estimated at 100,000 fish (Faurot et al. *In preparation*). Chinook and sockeye salmon escapements into the Chickaloon River during 1985 were estimated at 3,000-5,000 and 4,000-6,000 fish, respectively. No escapement estimate was obtained for coho salmon, however, the return in 1984 appeared much stronger than the 1985 escapement.

Ten other fish species were documented in the Chickaloon watershed during the 1984-1985 surveys. Threespine stickleback was the most common resident species. Arctic lamprey, coastrange sculpin, ninespine stickleback, and starry flounder were found exclusively in the lower river. Rainbow trout and Dolly Varden were found throughout the river and in several lakes in the watershed. The ten named lakes in the watershed also support populations of lake trout, round whitefish, longnose sucker, threespine stickleback, and slimy sculpin.

Big and Little Indian Creeks

Big and Little Indian creeks drain mountainous watersheds on the west side of the Kenai Mountains into Chickaloon Bay, a part of Turnagain Arm (Figure 2). Big Indian Creek has spawning populations of chinook, pink, sockeye, and coho salmon. Little Indian Creek supports coho and pink salmon (Alaska Department of Fish and Game 1993). These populations have not been studied, so little is known of run size or timing. The resident fish populations of these streams remain unknown.

Pincher Creek

Pincher Creek is 13 km (8 mi) long and drains a lowland watershed of 84 km² (33 mi²) into Chickaloon Bay of Turnagain Arm (Figure 2). Fish species found in this watershed include coho salmon, Dolly Varden, rainbow trout, and threespine and ninespine stickleback. Three of the four named lakes in this watershed have been surveyed. Two Island Lake is the only surveyed lake which supports sport fish populations (U.S. Fish and Wildlife Service, unpublished data).

Bedlam Creek

Bedlam Creek drains 39 km² (15 mi²) of lowland forest habitat into Turnagain Arm (Figure 2). This stream is 10 km (6 mi) long and has not been surveyed. Five lakes are in the watershed and all have been surveyed. Bedlam and Mull lakes support populations of rainbow trout and kokanee. Bedlam Lake supported coho salmon when surveyed in 1964, but this species was not found when the lake was resurveyed in 1972 or in 1983 (U.S. Fish and Wildlife Service, unpublished data). Ocean access to the lake may be blocked, restricting movement into the lake.

Dipper Creek

This creek drains 28 km² (11 mi²) of forested lowland habitat into Turnagain Arm (Figure 2). The stream has not been surveyed. Tangerra Lake, one of three named lakes in the watershed, was surveyed in 1984 and supports a rainbow trout population (U.S. Fish and Wildlife Service, unpublished data).

Fox River

The Fox River originates in the Kenai Mountains at the base of Chernof Glacier and empties into Kachemak Bay approximately 32 km (20 mi) northeast of Homer (Figure 2). The watershed covers approximately 482 km² (186 mi²), 79% of which lies within the refuge boundaries. Approximately 78 km² (30 mi²) of the watershed are glaciated, resulting in high suspended sediment and bedload during the spring, summer, and fall months. Clearwater Slough and Clay Creek, both clear water streams, are the largest tributaries to the Fox River, draining watersheds of 49 km² (19 mi²) and 59 km² (23 mi²), respectively. Windy Lake is the largest (17 hectares [42 acres]) of three lakes in the drainage (Faurot and Palmer 1992).

Eleven fish species have been identified in the Fox River watershed including five species of Pacific salmon, Dolly Varden, eulachon, threespine and ninespine stickleback, and coastrange and slimy sculpin. A survey conducted by the Service during 1985 and 1986 (Faurot and Palmer 1992) found coho salmon were the most abundant and widely distributed salmon species in the drainage. Adult coho salmon return to the Fox River starting in August and spawn primarily in Clearwater Slough, Clay Creek, and the mainstem Fox River. Other salmon species return to the Fox River during July and early August. Escapement estimates for Clearwater Slough and Clay Creek based on spawner counts in 1986 were 3,554 coho salmon, 2,084 sockeye salmon, and 325 chum salmon. Approximately 200 pink salmon and six chinook salmon were observed spawning in Clearwater Slough during 1985.

Clearwater Slough provides sport fishing for coho and sockeye salmon and Dolly Varden. An angler survey in 1985 (Faurot and Palmer 1992) found that the majority of angling effort was focused toward coho salmon. However, some anglers fished for sockeye salmon during July and Dolly

Varden were targeted when salmon fishing was slow. Anglers reported catch rates of 0.2-1.1 sockeye salmon and 1.0-4.3 coho salmon per hour.

Sheep Creek

Sheep Creek originates from Glacier Lake, which lies at the base of Dinglestadt Glacier, and flows 24 km (15.1 mi) to Kachemak Bay (Figure 2). Glaciers make up nearly 36% of the 337 km² (130 mi²) watershed. Glacially turbid discharges have created an unstable braided channel. Sheep Creek shares a common delta with the Fox and Bradley rivers.

Sheep Creek supports populations of coho and pink salmon and Dolly Varden (Alaska Department of Fish and Game 1993). Little is known about the run size or timing of these populations, however, glacial conditions found in this watershed probably limit the amount of spawning and rearing habitat available to salmon and char.

Sheep Creek and the Fox River may experience increased human activity in the future associated with the Bradley River hydroelectric project (U.S. Army Corps of Engineers 1982). Since the lower reaches of these watersheds are off the refuge, developments may occur which could alter the present aquatic environment.

Martin River

The Martin River originates at the Dixon Glacier and flows north into Kachemak Bay (Figure 2). This stream drains a watershed of 41 km² (16 mi²), but only 41% of the watershed is on the Kenai Refuge. The refuge portion of the watershed includes three headwater tributaries and a small unnamed lake. The Martin River is listed as supporting chum and sockeye salmon and Dolly Varden (Alaska Department of Fish and Game 1993).

SECTION 4. HUMAN USES AND MANAGEMENT HISTORY

The fishery resources of the Kenai Refuge play a major role in the regional economy and culture of the Kenai Peninsula. This section of the Fishery Plan describes that role, how fishery resources were used in the past, how they are used today, and the kinds of uses that can be anticipated in the future. A summary of fishery management activities carried out on the Kenai Refuge over the past 30 years is presented in Table 5. The primary focus of past management activities has been to provide fishery resources for various human and wildlife uses while maintaining healthy fish populations. This goal will continue to be the primary focus of future management activities on the Kenai Refuge.

All commercial, subsistence, and sport fisheries which harvest fish of refuge origin are regulated by the Alaska Board of Fisheries. Commercial and subsistence fisheries are managed by the Department's Commercial Fisheries Management and Development Division and sport fisheries are managed by the Department's Division of Sport Fish. Guidelines for management are provided by several management plans enacted by the Alaska Board of Fisheries.

Commercial Fisheries

Records of commercial fishing in Cook Inlet date back to 1882. Since then many gear types, including fish traps, gill nets, and seines have been used with varying degrees of success to harvest salmon. Currently, commercial fishing gear is restricted to set and drift gill nets in the Upper Cook Inlet Management Area (Central and Northern districts) north of the latitude of Anchor Point with the exception of a seine fishery in Chinitna Bay (Figure 3). Purse seines and set gill nets are used to harvest salmon in the Lower Cook Inlet Management Area (Southern, Kamishak, Barren Islands, Outer, and Eastern districts) south of Anchor Point (Figure 4).

Salmon harvested in the Lower Cook Inlet Management Area account for approximately 25% of the commercial salmon harvest in Cook Inlet. Pink salmon are the dominant species harvested and account for 77% of the total salmon harvest (Bucher and Hammarstrom 1993). Few salmon harvested in Lower Cook Inlet are of refuge origin.

The Upper Cook Inlet Management Area generally accounts for 75% of the commercial salmon harvest in Cook Inlet. Sockeye, coho, chum, pink, and chinook salmon are harvested in that order of economic importance (Ruesch and Fox 1994). Many of the salmon commercially harvested in Upper Cook Inlet are of refuge origin.

The commercial harvest of sockeye salmon in Upper Cook Inlet has increased substantially in the last 25 years (Table 6). Annual catches in the early 1970's were less than 1 million fish. Since 1976 sockeye stocks have rebounded from a combination of milder winters, reduced offshore harvest, various enhancement programs, and improved management of escapements. Average annual commercial harvest from 1976 through

Table 5.-Summary of fishery management activities carried out on the Kenai National Wildlife Refuge, Alaska.

River/lake	Management activity	Chronology	Agency
Kenai River	Chinook salmon stock assessment and harvest	1993 - present	Department
	Coho salmon stock assessment and harvest	1992 - present	Department
	Assessment of cumulative impacts of development and human uses on fish habitat	1992 - 1993	Department
	Chinook salmon hook and release mortality study	1989 - 1991	Department
	Coho salmon run timing and spawning distribution study	1988 - 1989	Service
	Rainbow trout population dynamics study	1986 - 1987	Department
	Rearing/habitat utilization studies on juvenile salmon	1986 - 1988 1979 - 1981	Department Service
	Chinook salmon spawning distribution study	1979 - 1981	Service
	Coho salmon creel survey	1975 - 1992	Department
	Chinook salmon creel survey	1974 - 1991	Department
Beaver Creek	Juvenile fish study	1982 - 1984	Service
Slikok Creek	Salmon escapement surveys	1991 - present	Department
	Juvenile fish study	1982 - 1984	Service
Moose River	Coho salmon smolt monitoring	1992 - present	Department
	Anadromous and resident fish investigation	1985 - 1986	Service
Killey River	Chinook salmon counting weir	1981	Service
Hidden Creek and Hidden Lake	Creel survey	1992 - 1994	Service
	Coho salmon smolt monitoring	1992 - 1993	Department
	Sockeye salmon dipnet fishery	1991	Department & Service
	Lake trout age, weight, length study	1987	Department
	Sockeye salmon stocking	1977 - present	Department & CIAA*
	Sockeye salmon egg take	1976 - present	Department & CIAA
	Sockeye salmon smolt monitoring	1976 - present	Department & CIAA

Table 5.-(Continued).

River/lake	Management activity	Chronology	Agency
Hidden Creek and Hidden Lake	Limnological surveys	1976 - present	Department & CIAA
	Sockeye salmon counting weir	1971 - present	Department & CIAA
Russian River	Smolt monitoring	1993 - present	Department
		1978 - 1979	Department
	Fish by-pass construction	1978	Department
	Egg density study	1974 - 1981	Department
	Adult salmon counting weir	1969 - present	Department
	Creel survey	1963 - present	Department
	Adult salmon counting tower	1960 - 1968	Department
Swanson River	Stream diversion	1958	Service
	Anadromous and resident fish investigation	1988 - 1989	Service
	Adult salmon counting weir	1988 - 1989	Service
		1962 - 1967	Department
	Rainbow trout egg take	1982 - 1984	Department
Chickaloon River		1979	Department
		1974 - 1976	Department
Chickaloon River	Anadromous and resident fish investigation	1984 - 1985	Service
Fox River	Anadromous and resident fish investigation	1985 - 1986	Service
Kasilof River and Tustumena Lake	Sockeye salmon genetics study	1992 - 1993	Service
	Sockeye salmon fry outmigration study	1990 - 1992	Service
	Sockeye salmon spawning distribution study	1989 - 1991	Service
	Chinook salmon egg take	1988 - present	Department
	Run timing and spawning distribution of coho and late-run chinook salmon	1987	Service
	Resident fish investigation	1987	Service
	Hydroacoustic surveys	1981 - present	Department
	Limnological surveys	1980 - present	Department
	Smolt monitoring	1980 - present	Department
	Sockeye salmon stocking	1976 - present	Department & CIAA
	Sockeye salmon egg take	1975 - present	Department & CIAA

Table 5.--(Continued).

River/lake	Management activity	Chronology	Agency
Kasilof River and Tustumena Lake	Spawning ground surveys Sockeye salmon sonar counter	1975 - 1992 1968 - present	Department Department
Twin Lakes	Arctic grayling stocked	1965	Department
Lower Fuller Lake	Arctic grayling stocked	1967	Department
Engineer Lake	Coho salmon stocked on alternate years	1975 - 1992	Department
Upper Jean Lake	Trout and salmon stocking	1962 - 1983	Department
Portage Lake	Coho salmon stocking	1966 - 1990	Department
Rock Lake	Coho salmon stocking	1966 - 1971	Department
Sunken Island Lake	Trout and salmon stocking	1961 - 1971	Department
Bottenintnin Lake	Salmon stocking	1965 - 1967	Department
Remote and roadside lake inventory ^b	Fishery and limnological surveys	1983 - 1985 1993	Service Service

^a Cook Inlet Aquaculture Association^b Includes 75 lakes located throughout the Kenai National Wildlife Refuge.

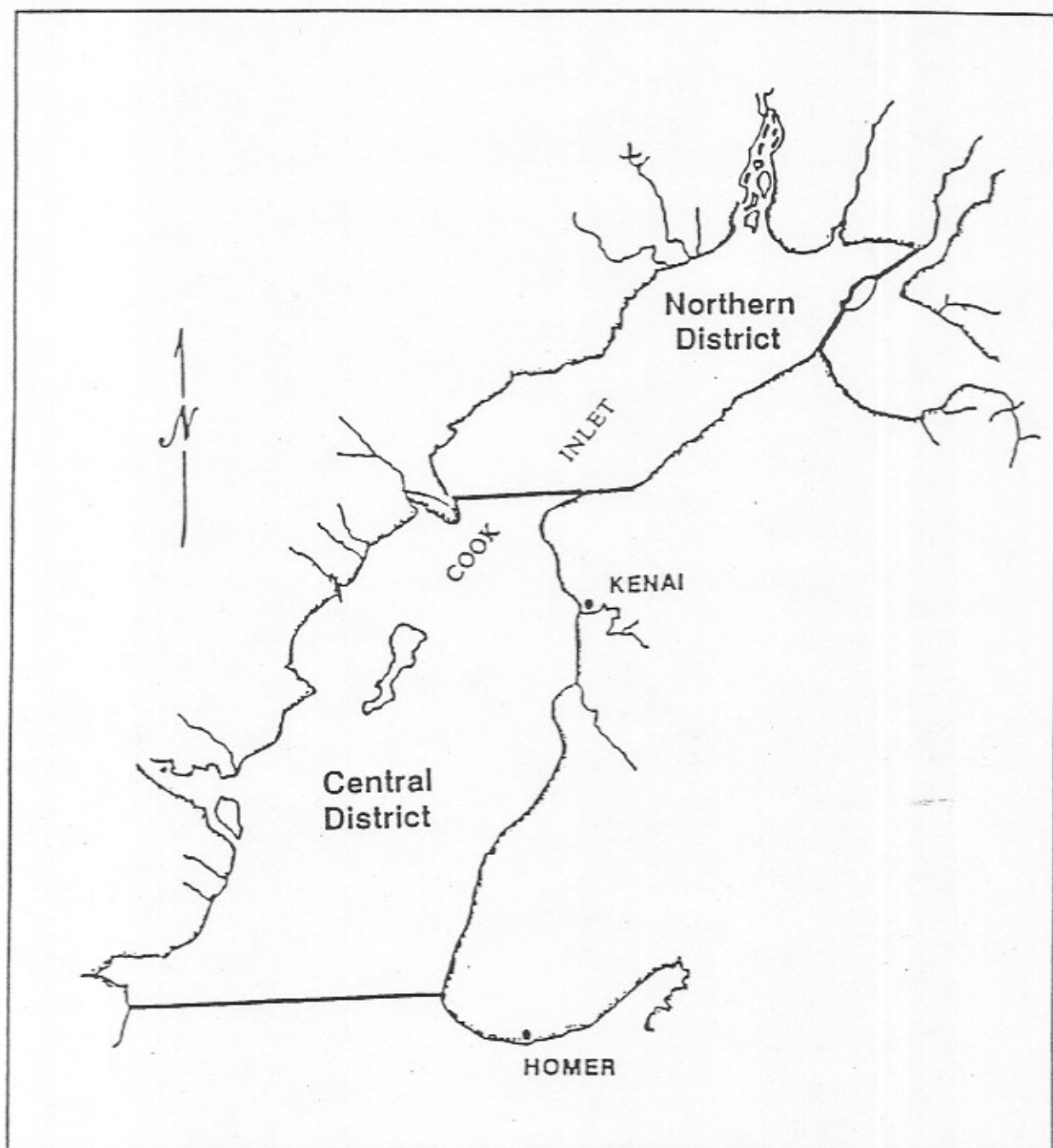


Figure 3.—Commercial fishing districts in the Upper Cook Inlet Management Area.

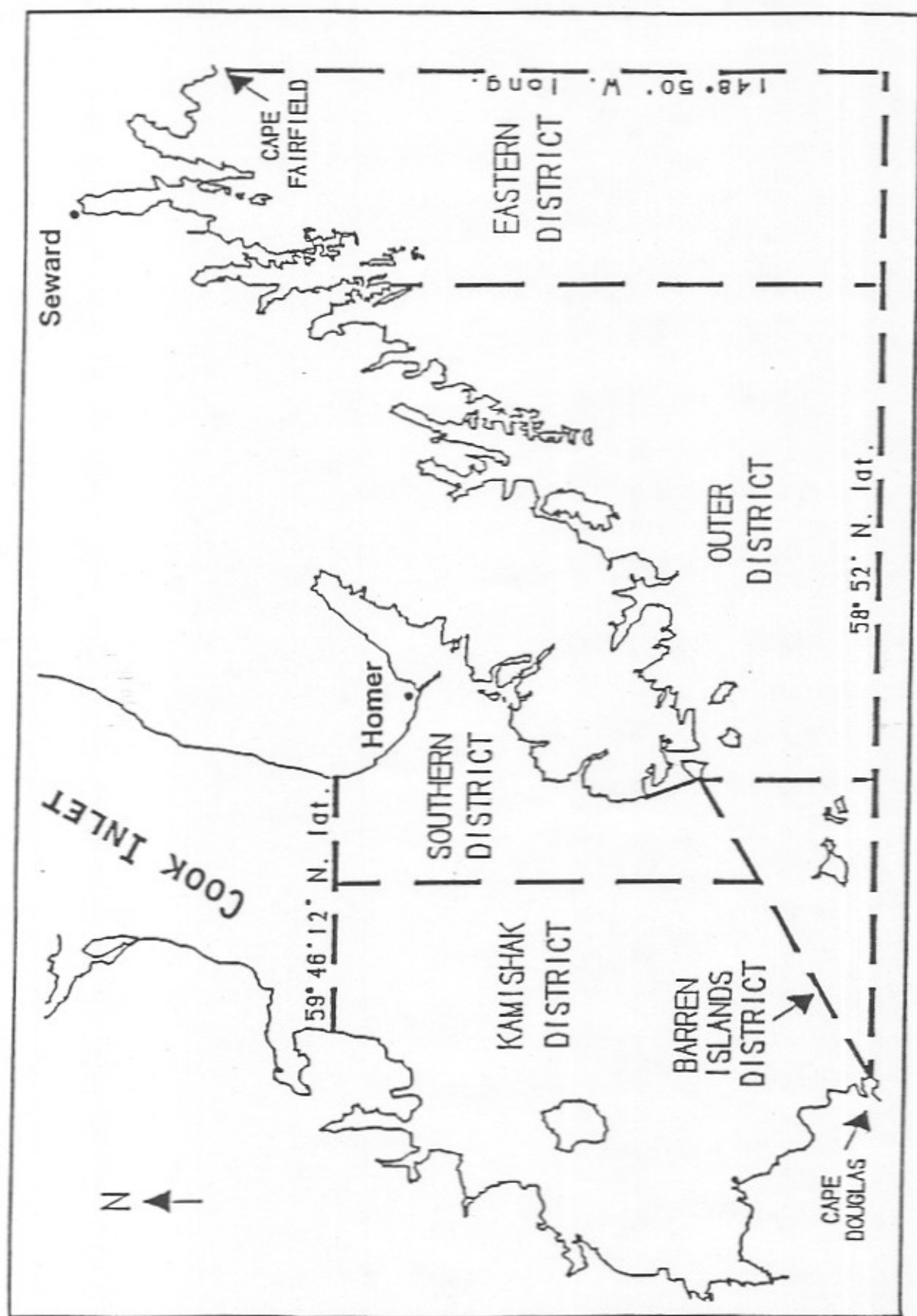


Figure 4.-Commercial fishing districts in the Lower Cook Inlet Management Area.

Table 6.—Commercial salmon catches in Upper Cook Inlet, 1970-1993^a.

Year	Species					Total
	Chinook	Sockeye	Coho	Pink	Chum	
1970	8,336	732,605	275,399	814,895	776,229	2,607,464
1971	19,765	636,798	100,636	35,624	327,029	1,119,852
1972	16,086	879,724	80,933	628,576	630,016	2,235,335
1973	5,194	670,025	104,373	326,183	667,561	1,773,336
1974	6,586	497,160	200,125	484,035	396,938	1,584,844
1975	4,773	678,736	221,739	335,629	950,981	2,191,858
1976	10,867	1,664,131	208,710	1,256,743	469,806	3,610,257
1977	14,792	2,052,511	192,599	553,855	1,233,722	4,047,479
1978	17,302	2,621,667	219,360	1,689,098	571,959	5,119,386
1979	13,738	924,415	265,166	72,982	650,357	1,926,658
1980	13,795	1,573,637	271,378	1,786,430	390,810	4,036,050
1981	12,240	1,439,235	485,148	127,169	833,549	2,897,341
1982	20,870	3,259,864	793,937	790,648	1,433,866	6,299,185
1983	20,634	5,049,733	516,322	70,327	1,114,858	6,771,874
1984	10,041	2,105,860	449,903	617,298	680,089	3,863,191
1985	24,086	4,060,260	667,213	87,828	772,829	5,612,216
1986	39,240	4,787,982	756,830	1,299,360	1,134,173	8,017,585
1987	39,661	9,500,186	451,404	109,801	349,132	10,450,184
1988	29,060	6,834,342	560,022	469,972	708,573	8,601,969
1989	26,742	5,010,698	339,201	67,430	122,027	5,566,098
1990	16,105	3,604,064	500,026	603,630	351,197	5,075,022
1991	13,535	2,177,576	425,724	14,663	280,223	2,911,721
1992	17,171	9,108,340	468,911	695,859	274,303	10,564,584
1993	18,719	4,754,698	306,822	100,918	122,767	5,303,924
Average	17,472	3,109,344	369,245	543,290	635,125	4,674,476

^a Source: Ruesch 1994

1993 has been nearly 4 million fish (Ruesch and Fox 1994). The bulk of the commercial harvest is comprised of fish returning to the Kenai, Kasilof, and Susitna rivers.

The majority of chum salmon returning to Upper Cook Inlet are bound for the Susitna River. The commercial harvest occurs primarily in the drift gill net fishery (87%) and has averaged about 230,000 annually since 1989 (Table 6). This level of harvest is substantially lower than the long-term average of over 600,000 fish (Ruesch and Fox 1994). Most chum salmon are harvested coincidentally with sockeye salmon and management measures directed at sockeye salmon often influence the chum salmon harvest.

Pink salmon have been a major component of the Upper Cook Inlet commercial fishery since the early 1900's and occur in substantial numbers only in even-numbered years. Since 1970, commercial harvest during even-numbered years has averaged nearly 1 million fish annually (Table 6). Returns to the Kenai and Susitna rivers account for the majority of pink salmon production in Upper Cook Inlet (Ruesch and Fox 1994).

The commercial harvest of coho salmon in Upper Cook Inlet has averaged over 500,000 fish annually since 1981 (Table 6). This level of harvest is more than twice the average annual harvest which occurred during the 1970's (Ruesch and Fox 1994). Although coho salmon return to nearly every stream and river in Upper Cook Inlet, stocks being exploited in the commercial fishery are primarily returns to the Susitna and Kenai rivers and numerous streams along the west side of Cook Inlet.

The commercial harvest of chinook salmon in Upper Cook Inlet has averaged over 20,000 fish annually from 1981-1993 (Table 6). The principal stock of chinook salmon harvested in the commercial fishery is the late run to the Kenai River. These fish are harvested incidentally by set gill nets targeting sockeye salmon on the east side of Cook Inlet. An average of over 13,000 chinook salmon were harvested annually during the 1980's in the commercial set net fishery (Ruesch and Fox 1994). This harvest frequently exceeds the sport fish harvest and generates a major controversy between recreational anglers on the Kenai River and commercial set netters.

The economic value of salmon commercially harvested in Upper Cook Inlet has increased substantially since 1970 (Table 7). The estimated ex-vessel value of salmon has increased from about \$5,000,000 annually during 1970-1975 to nearly \$66,000,000 annually during 1987-1993 (Ruesch and Fox 1994). Sockeye salmon are by far the most valuable component of the catch comprising over 90% of the estimated ex-vessel value from 1987-1993.

Commercial fishing periods in Cook Inlet are established by regulation and in-season management of harvest is accomplished through the emergency order process. Information obtained from a variety of programs is used for in-season management of harvest. These programs

Table 7.-Estimated ex-vessel value (dollars) of salmon commercially harvested in Upper Cook Inlet, 1970-1993^a.

Year	Species					Total
	Chinook	Sockeye	Coho	Pink	Chum	
1970	49,000	1,135,000	354,000	387,000	745,000	2,670,000
1971	189,000	1,102,000	143,000	22,000	316,000	1,772,000
1972	217,000	1,795,000	135,000	473,000	834,000	3,454,000
1973	122,000	3,214,000	320,000	363,000	2,134,000	6,153,000
1974	210,000	3,058,000	843,000	946,000	1,521,000	6,578,000
1975	65,000	2,596,000	821,000	423,000	2,753,000	6,658,000
1976	276,000	8,626,000	818,000	1,879,000	2,040,000	13,639,000
1977	525,000	13,274,000	933,000	772,000	5,991,000	21,495,000
1978	667,000	26,128,000	1,388,000	2,154,000	2,217,000	32,554,000
1979	625,000	8,094,000	1,658,000	89,000	4,201,000	14,667,000
1980	417,000	7,932,000	902,000	2,114,000	1,516,000	12,881,000
1981	422,000	11,071,000	2,638,000	179,000	2,005,000	16,315,000
1982	753,000	25,029,000	4,139,000	515,000	5,851,000	36,287,000
1983	585,000	23,841,000	1,603,000	38,000	3,195,000	29,262,000
1984	311,990	12,445,633	2,041,480	522,419	2,007,827	17,329,349
1985	799,173	27,479,840	3,358,083	57,440	2,646,553	34,341,089
1986	881,356	37,665,832	2,838,881	698,527	3,123,485	45,208,081
1987	1,609,681	96,331,886	2,368,968	84,547	1,115,477	101,510,559
1988	1,204,321	111,102,230	4,731,340	650,309	4,113,356	121,801,556
1989	803,494	56,194,753	1,674,393	86,012	415,535	59,174,187
1990	436,822	35,804,485	2,419,202	512,590	1,495,827	40,668,906
1991	348,553	12,259,753	1,996,348	5,472	643,392	15,253,518
1992	634,383	96,038,337	2,262,323	404,990	740,618	100,080,651
1993	462,819	27,969,409	1,081,175	36,935	322,205	29,872,543

^a Source: Ruesch 1994

include offshore test fishing, escapement enumeration by sonar and weir, comparative analysis of historic commercial harvest and effort levels, and age composition studies.

Subsistence and Personal Use Fisheries

Subsistence fisheries on the Kenai Peninsula are regulated by both state and federal governments. Federal subsistence management regulations apply to both navigable and nonnavigable waters on the Kenai Refuge. Only residents of rural communities that have been determined to have customarily and traditionally harvested fish for subsistence purposes are eligible to fish under those regulations. While there are nine communities on the Kenai Peninsula¹ that have been identified as rural, only the communities of Port Graham and Nanwalek have been determined to have customarily and traditionally harvested fish for subsistence purposes. Residents of those communities may harvest only Dolly Varden in the Port Graham Subdistrict and salmon in the Koyuktolik Subdistrict. Both subdistricts are south of the Kenai Refuge. Until such time as determinations have been made by the Federal Subsistence Board, harvests of fish by residents of other communities under Federal subsistence management regulations are prohibited. Although federal subsistence regulations are currently in place, the State of Alaska is disputing federal authority to regulate subsistence fisheries through a judicial resolution.

State of Alaska subsistence and personal use fishing regulations on the Kenai Peninsula have been evolving for several years as a result of court action. Subsistence fishing was permitted in 1991 and 1992. In 1993, the region was determined to be a "No Subsistence Area" and only personal use fishing was allowed. In 1994, "No Subsistence Areas" were eliminated and subsistence fishing was once again allowed. If future determinations declare Upper Cook Inlet to be a "No Subsistence Area", personal use fisheries that previously occurred at the mouths of the Kasilof and Kenai rivers will be reinstated. The following discussion describes subsistence and personal use fisheries which harvest salmon of refuge origin.

Upper Cook Inlet Subsistence Fishery

This subsistence fishery allows participants to use a 10-fathom set gill net to harvest salmon in most marine waters of Upper Cook Inlet normally open to commercial set gill nets. In addition, dip net fisheries occur in the mouths of the Kenai and Kasilof rivers. Fishing periods are established by regulation on select Wednesdays and Saturdays from 8:00 a.m. to 8:00 p.m. Each permit holder can harvest 25 salmon of which no more than five can be chinook salmon. Each dependent of the permit holder is permitted ten salmon of which no more than one can be a chinook salmon. Participants reported a harvest of 71,719 salmon in

¹Cooper Landing, Ninilchik, rural areas around Homer, Nanwalek, Port Graham, Seldovia, Halibut Cove, China Poot, and Hope.

this fishery during 1994 (Ruesch and Fox 1995). The majority (68%) of salmon were harvested in the vicinity of the Kenai and Kasilof rivers with sockeye salmon comprising 82% of that catch.

Kenaitze Tribal Fishery

The Kenaitze Tribal Fishery was granted to the Kenaitze Tribe under a consent preliminary injunction issued in 1989 from the U.S. District Court. A permit for the fishery has been issued each year since 1989 which allows the operation of a single 10-fathom set gill net in the Kenai River downstream from a point one-quarter mile above the Warren Ames Bridge and including marine waters adjacent the river mouth normally closed to commercial salmon fishing. Fishing is permitted from June 1 to September 1 and from September 16 to September 30. A total of 5,000 salmon can be harvested with quotas of no more than 300 chinook salmon and no more than 500 coho salmon taken after September 15. The harvest reported by the tribal office in 1993 totaled 145 chinook, 1,533 sockeye, 1 pink, and 477 coho salmon (Ruesch and Fox 1994).

Kachemak Bay Subsistence Fishery

The Kachemak Bay Subsistence Fishery is a set gill net fishery that dates back prior to statehood. The target species is coho salmon, with returning fish comprised of natural stocks bound primarily for the Fox River and adults returning to enhancement sites at Caribou Lake and the Homer Spit. All waters of the Southern District in Lower Cook Inlet are open to fishing with the exception of areas at the base and tip of Homer Spit and from the Anchor River south to Troublesome Creek. Salmon are harvested during two regularly scheduled 48-hour fishing periods each week from August 16-September 15 or until 2,500-3,500 coho salmon have been harvested. Participants must obtain a permit issued by the Department in Homer. Each permit holder can set one 35-fathom gill net and harvest 25 salmon for the head of household and 10 salmon for each dependent. The harvest of salmon in this fishery has averaged 4,071 fish annually from 1969-1994 (Bucher and Hammarstrom 1995). Coho salmon comprise the majority (78%) of this harvest.

Sport Fisheries

The Kenai Peninsula plays a major role in providing recreational fishing opportunities in southcentral Alaska. The Kenai Peninsula supported 946,252 angler-days or 37% of the state's total sport fishing effort during 1993 (Mills 1994). The Kenai River is the most intensively fished river in Alaska and supported 324,120 angler-days or 13% of the state's total sport fishing effort in 1993.

The rate of growth and economic importance of recreational fisheries on the Kenai Peninsula have increased substantially in recent years. In a 13-year period, from 1981 to 1993, a 69% increase in sport fishing effort was observed on the Kenai Peninsula (Mills 1982, 1994). During that same time period, sport fishing effort on the Kenai River increased by 81%. Although many Kenai Peninsula residents participate in local

recreational fisheries, many anglers are from the Anchorage area and an increasing number are nonresident tourists. These visitors contribute significantly to the economy of the Kenai Peninsula. Anchorage residents and nonresidents (anglers and non-anglers) spent an estimated \$91 million while visiting the Kenai Peninsula during 1991 (Kenai Peninsula Borough 1992).

All five species of salmon are taken by the region's sport fisheries, however, chinook, coho, and sockeye salmon are most sought after by anglers. In terms of numerical harvest, greater numbers of sockeye salmon are caught than other salmon species. The number of salmon available to anglers is sometimes influenced by the harvest in the commercial fishery. Most salmon runs returning to refuge streams are subjected to some type of commercial harvest except early-run sockeye, early-run chinook, and late-run coho salmon returning to the Kenai River. These runs are all managed for the recreational fishery.

Several recreational fisheries of statewide importance occur on the refuge or are supplemented by refuge produced fish. The recreational fisheries listed in Table 8, either through recreational fishing within the refuge or from refuge produced fish, contributed 90% of the salmon, 77% of the rainbow trout, 64% of the Dolly Varden/Arctic char and 57% of the lake trout to the freshwater recreational catch on the Kenai Peninsula during 1993 (Mills 1994). Other species caught in the recreational fishery on the refuge include Arctic grayling and round whitefish.

The majority of sport fishing on the refuge occurs as unguided fishing on the Russian and Kenai rivers, Hidden Lake and the two canoe systems. Guided fishing effort on the refuge occurs on the Kenai River above and below Skilak Lake and in the two canoe systems. In addition, commercially operated tent camps on King, Wilderness, McClain, Snag, Bird, Tangerra, Mull, and Bedlam lakes provide fishing opportunities in less accessible parts of the refuge.

Table 8.-Sport fishing effort and catch and adjacent the Kenai National Wildlife Refuge during 1993 (Mills 1994).

Location	Angler days	Species caught				
		Sockeye salmon ^a	Pink salmon ^b	Rainbow trout	Dolly Varden ^c	Lake trout
Kenai Peninsula Freshwater	573,704	53	335,852	97,690	123,353	140,112
8,089						
Refuge Sport Fisheries^d						
Kenai River	324,120	33	230,594	74,021	62,152	76,327
921						
Russian River	61,018	21	91,851	1,823	12,377	4,141
0						
Kasilof River	57,127	69	3,719	449	778	4,718
202						
Crooked Creek	3,321	66	10	9	513	1,768
0						
Hidden Lake	5,030	26	698	0	339	127
2,358						
Swanson River	5,690	88	201	119	2,431	201
0						
Canoe routes ^e	5,150	67	84	0	14,818	1,480
0						
Skilak Lake	3,289	48	3,407	110	857	653
1,050						
Tustumena Lake	1,055	87	19	9	129	517
92						
Total	465,800	05	330,583	76,540	94,394	89,932
4,623						
% Kenai Peninsula Freshwater	81%	%	98%	78%	77%	64%
57%						

^a Includes kokanee.

^b Pink salmon catch is reported for 1992 to reflect higher even-year abundance.

^c Includes Arctic char.

^d Sport fisheries on the Kenai Refuge or 1th refuge produced fish.

^e Swanson River and Swan Lake canoe route.

SECTION 5. ISSUES AND CONCERNS

This section of the Fishery Plan provides a listing and discussion of the various fishery management issues and concerns that have been identified for the Kenai Refuge and adjacent lands. A number of general issues and concerns have been identified by the public and government agencies in the Kenai Refuge Comprehensive Conservation Plan and in the Kenai River Comprehensive Management Plan (Alaska Department of Natural Resources 1986)(Table 9). In a separate process, more specific issues and concerns were identified by the Kenai Fishery Resource Office in meetings with the Kenai Refuge staff and Department personnel (Table 10). These issues are narrower in scope than those identified in the other plans and apply to specific watersheds and fish species.

Source Documents

Kenai Refuge Comprehensive Conservation Plan

Preparation of the Kenai Refuge Comprehensive Conservation Plan included several public meetings and technical workshops. The purpose of these meetings and workshops was to identify issues and concerns of the public, other agencies and the Service that the plan needed to address.

Public meetings were held in Seward, Soldotna, Homer, and Anchorage in 1980. Common concerns at the three Kenai Peninsula cities were for greater federal and state cooperation in the management of resources, and the role of local residents in decision making. Enhancement to benefit sport fisheries was identified as a top priority by some Anchorage participants, while others believed the refuge should be managed to benefit all species. Anchorage participants also stressed the need to conduct intensive research and gather baseline data on refuge resources. Comments received at the Anchorage meeting favored more non-consumptive recreational opportunities and less development on the refuge.

Written comments were received from individuals and groups following the four public meetings. Although most came from residents of the Kenai Peninsula, many were from the Anchorage area. The concerns ranged from the artificial enhancement of fisheries to public access and wilderness management. Many recreationists spoke of the need for intensive law enforcement in refuge recreational facilities.

In 1982, the Service brought together a number of specialists on wildlife, fisheries, and recreational resources of the Kenai Peninsula for a series of workshops in Soldotna. Participants represented state, local and federal agencies as well as private interests. Both state and private fisheries specialists were concerned that activities on the refuge might be restricted or inhibited by refuge management policy or zoning. Most wildlife specialists emphasized the need to maximize not only the consumptive but non-consumptive values. Some participants expressed concern that motorized access in the Kenai Wilderness was too liberal, while others believed overall access on the refuge was too

Table 9.-Fishery related issues and concerns for the Kenai National Wildlife Refuge and adjacent lands.

Issues and Concerns	Kenai Refuge Comprehensive Conservation Plan-1985	State Position Paper-1983	Kenai River Comprehensive Management Plan-1986
Fisheries enhancement	X	X	X
Habitat protection	X	X	X
Need for additional fish and wildlife data	X	X	X
Less than full utilization of habitat potential	X	X	
Effects of intensive public use on fish and wildlife	X		X
Impacts of resource development on fish and wildlife	X	X	X
Fishery enhancement activities in Wilderness	X		
Law enforcement needs	X		X
Access and transportation	X	X	X
Information and education	X	X	X
Interagency coordination	X	X	X
Allocation of fish stocks	X		X
Water quality and quantity	X		X

Table 10.—Fishery issues and concerns identified for various watersheds on the Kenai National Wildlife Refuge, Alaska.

Watershed	Issue/Concern
Kenai River	<ul style="list-style-type: none"> • bank erosion • habitat degradation caused by development off the refuge • damage to streambanks and riparian vegetation related to fishing pressure • loss of contiguous wetlands and juvenile salmonid rearing habitat • little known about run size of coho salmon • salmon runs heavily exploited by many user groups • little is known about the population dynamics of rainbow trout or Dolly Varden • adequate escapement of late-run coho salmon to upper Kenai River to support overwintering eagle population
Beaver Creek	<ul style="list-style-type: none"> • potential water withdrawals for domestic or commercial use • pollutants from Beaver Creek Oil Field
Slikok Creek	<ul style="list-style-type: none"> • potential pollutants from Borough landfill • potential water withdrawals for domestic or commercial use • potential impacts from livestock grazing
Funny River	<ul style="list-style-type: none"> • lack of data
Moose River	<ul style="list-style-type: none"> • potential impacts on native species from introduction of exotic northern pike
Killey River	<ul style="list-style-type: none"> • lack of data
Hidden Creek	<ul style="list-style-type: none"> • potential impact of hatchery reared sockeye salmon on native stock and other resident species • data base for resident fish lacking • little is known about the population dynamics of coho salmon
Russian River	<ul style="list-style-type: none"> • damage to streambank and riparian vegetation related to fishing pressure • conflicts between bears and anglers during the sockeye salmon run

Table 10.-(continued)

Watershed	Issue/Concern
Kasilof River	<ul style="list-style-type: none"> • potential impact of hatchery reared sockeye salmon on native stock and other resident species • fishery enhancement activities in a Wilderness Area • little known about run size of late-run chinook salmon and coho salmon • egg take from late-run chinook salmon may be impacting wild spawners
Chickaloon River	<ul style="list-style-type: none"> • little known about salmon run sizes
Swanson River	<ul style="list-style-type: none"> • potential water withdrawals for commercial use • pollutants from Swanson River Oil Field • increasing human use
Fox River	<ul style="list-style-type: none"> • lack of enforcement • increasing human use
Sheep Creek	<ul style="list-style-type: none"> • lack of data • increasing human use
Big Indian Creek	<ul style="list-style-type: none"> • lack of data
Little Indian Creek	<ul style="list-style-type: none"> • lack of data
Seven Egg Creek	<ul style="list-style-type: none"> • lack of data
Pincher Creek	<ul style="list-style-type: none"> • lack of data
Otter Creek	<ul style="list-style-type: none"> • lack of data
Scaup Creek	<ul style="list-style-type: none"> • lack of data
Bedlam Creek	<ul style="list-style-type: none"> • lack of data
Miller Creek	<ul style="list-style-type: none"> • lack of data
Dipper Creek	<ul style="list-style-type: none"> • lack of data

limited. Many believed there was a general lack of sufficient and easily accessible information on recreational, interpretive, and educational opportunities on the refuge.

State Position Paper

Early in 1983, the State of Alaska provided the Service with a set of draft resource management recommendations for the Kenai Refuge and surrounding area. These recommendations represented the State's current management policies and objectives, identified management issues, and recommended solutions. While this paper covered a broad spectrum of issues of concern to all state agencies, most recommendations were related to management of fish and wildlife resources.

The State advocated adoption of a liberal approach to public access. All refuge roads, trails, waterways, and aircraft landing areas that are now open should remain so. The State also stressed the importance of protecting critical areas such as stream confluences and spawning areas. In these critical areas, exploration or development of resources and development of refuge facilities (such as campgrounds, access trails, roads, or refuse disposal sites) should be avoided.

The State also advocated continuing its prerogative to carry out fisheries enhancement and conduct future investigations on the refuge. The State insisted that its ability to conduct aerial, ground, or boat surveys of fish and wildlife not be unduly restricted by cumbersome permit requirements. The State wanted to be allowed to erect and maintain any facilities or structures needed for fishery management. The State also asked that the Service adopt plans that are in substantial agreement with state fishery management plans.

Regarding public information, the state stressed that the Service should cooperate with the state in preparing publications on refuge resources and their use. These publications should explain to the public that consumptive use of fish and wildlife are compatible with ecosystems management and will be allowed on the refuge.

Kenai River Comprehensive Management Plan

The Kenai River Comprehensive Management Plan was completed in 1986 and is largely the product of the Kenai River Advisory Board, a 19-member group made up of private citizens and government agency representatives. Issues discussed in the plan involve a number of different agencies and jurisdictions and were developed through literature reviews, interviews with individuals and agency staff, meetings of the Kenai River Advisory Board and its subcommittees, public meetings conducted by the Department of Natural Resources, public opinion questionnaires, and a variety of other sources. Issues discussed in the plan are organized into general categories including fish and wildlife management, habitat protection, water quality and quantity, recreational activities and facilities, land use, management of public lands, commercial activities, permitting procedures, and interagency cooperation. The primary goal of the plan

was to protect and perpetuate the fishery and wildlife resources and habitat of the Kenai River Special Management Area and adjacent areas. Other goals of the plan were to protect and enhance public use, formulate policies and guidelines for development activities, and promote public understanding and appreciation of resource values. A Memorandum of Understanding between state and federal agencies was developed to assist in achieving goals of the plan (Appendix 1).

Major Issues and Concerns

Impact of Fishery Enhancement Activities on Natural Stocks

Enhancement programs can be an effective management tool in increasing the numbers of fish available to commercial fishermen and in increasing sport fishing opportunities. These programs, however, can have long term adverse impacts on natural stocks and require careful evaluation before they are implemented. Competition can occur between natural and hatchery-reared stocks of the same species or between natural and hatchery-reared stocks of different species and can occur in the freshwater, estuarine, or marine environments. Natural stocks can be subjected to overharvest in fisheries targeting hatchery-reared stocks. Natural stocks are a valuable resource; each population has evolved to meet the particular demands of the system in which they spawn and rear. Genetic differences between stocks are subtle and often poorly understood, but it is essential that we protect these stocks from attempts to realize short-term gains.

Loss of Habitat

Loss of habitat from human activity is occurring at an alarming rate on parts of the Kenai Peninsula. Residential and commercial development, especially along the Kenai River above and below the refuge, and bank trampling by anglers along many sections of river have impacted rearing habitats used by juvenile salmonids. Liepitz (1994) found that about 12 percent of the Kenai River's 134 miles of shoreline and nearshore habitats have been impacted by bank trampling, vegetation denuding, and structural development. Other threats to habitat and fish populations include mining activity outside the refuge and existing oil activities and gas activities within the refuge.

An issue of growing concern on the refuge is public use along the Kenai River corridor. Large numbers of anglers and others standing, walking, or camping along the shoreline have caused bank trampling and loss of riparian vegetation. This erosion process is accelerated in areas open to motorized watercraft by repeated wave attack from boat wakes (Reckendorf and Saele 1991). The vegetation loss and eventual sloughing of the bank into the river decreases the amount of cover available to juvenile salmonids. Nearshore areas are critical rearing areas for juvenile salmonids because they provide cover in the form of overhanging and aquatic vegetation, irregular and undercut banks, and woody debris (Bendock and Bingham 1988; Burger et al. 1983). Loss of cover and changes in streambank configuration can also increase water velocities

in nearshore areas beyond limits tolerated by juvenile salmonids. Water velocities exceeding about 2 ft/sec can interfere with the passage of chinook salmon fry which migrate upstream to overwintering areas in Skilak and Kenai lakes (Bendock and Bingham 1988).

Absence of Critical Data

Effective management and conservation of refuge fish populations and habitats is largely dependent on the availability of current and accurate information on status of the stocks, trends in their numbers, and an understanding of the environmental factors affecting them. Despite the long history of fish management and research on the refuge, little or no data exist on several streams and many lakes on the refuge because of the sheer size of the resource and the difficulty of access to some areas. Even less is known about separate spawning stocks within a single species, yet this information is critical for effective management, especially when harvest occurs in areas where two or more discrete stocks are present at the same time.

Information on angler use, angler harvest, and angler satisfaction is necessary for effective management of recreational fisheries. A sense of management direction can be obtained from this information as can a measure of management success.

Inadequate Fishery Law Enforcement

Law enforcement activity on the Kenai Refuge should be expanded to protect anadromous and resident fish stocks. The commercial, subsistence, personal use, and sport fisheries targeting refuge fish stocks are patrolled by Refuge Officers and State of Alaska Fish and Wildlife Protection Officers, but their areas of responsibility are too large and their personnel numbers are too small to effectively enforce regulations. Of the regulations in effect on the refuge, those that are designed to protect and rebuild rainbow trout populations have received the most support from the fishing public. Rainbow trout are particularly vulnerable during the spawning period and for that reason several refuge waters are closed to fishing for rainbow trout until mid-June. More restrictive harvest and size limits also have been imposed for some waters in recent years. There are indications, however, that these regulations are not being observed and law enforcement effort should be increased toward these activities.

Degradation of Water Quality and Quantity

Degradation of water quality and quantity is associated with many of the human activities that result in habitat losses. Commercial and residential development can alter surface run-off significantly, increasing turbidity and reducing recharge of ground water aquifers. It can also introduce problems with organic wastes. Commercial and residential development of land in the Cooper Landing area represents a very real problem with respect to domestic sewage and other residential waste products. Mining, especially placer mining, has often produced

serious water quality problems in Alaska. Development of oil and gas resources around the Swanson River drainage could, without adequate safeguards, produce contaminants such as phenols and other petroleum fractions. Roads in part of the oil field have already been contaminated with polychlorinated bi-phenols. A municipal landfill located off the refuge in the Slikok Creek drainage could potentially impact fishery resources originating on the refuge.

Oil companies and municipalities hold permits that could involve the withdrawal of substantial quantities of water in the Beaver Creek and Swanson River watersheds. Although federal water rights pre-date these permits, the Service must notify the state of our intent to assert our rights and quantify those waters necessary for achieving the purposes for which the refuge was established.

SECTION 6. GOALS AND OBJECTIVES

Goal A: Conserve fish and wildlife populations and habitats in their natural diversity including but not limited to salmonids.

Objective A-1: To administer the fishery management program on the Kenai Refuge as a continuing commitment through 2000.

Objective A-2: To manage the harvest of refuge fish populations in accordance with agency regulations as a continuing commitment through 2000.

Objective A-3: To monitor and evaluate refuge salmon stocks through 2000.

Objective A-4: To complete basic fishery resource inventories for major lakes and streams on the refuge by 2000.

Objective A-5: To evaluate sockeye salmon enhancement efforts on refuge waters through 2000.

Objective A-6: To determine the population dynamics of rainbow trout in the Kenai River by 1997.

Objective A-7: To determine the population dynamics of Dolly Varden in the Kenai River by 1997.

Objective A-8: To reduce bank trampling and prevent loss of riparian vegetation on rivers receiving high sport fishing use by 2000.

Objective A-9: To monitor the northern pike population in the Moose River through 2000.

Goal B: Fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats.

No objectives were identified.

Goal C: Ensure, to the maximum extent practicable and in a manner consistent with Goal A, water quality and necessary water quantity within the refuge.

Objective C-1: To develop a water quality and quantity data base for major lakes and streams on the refuge by 2000.

Objective C-2: To monitor water quality in the Kenai River drainage as a continuing commitment through 2000.

Goal D: Provide, in a manner consistent with Goals A and B, opportunities for scientific research, interpretation, environmental education, and land management training.

Objective D-1: To provide opportunities for the public to learn about fishery resources and aquatic habitats through 2000.

Goal E: Provide, in a manner compatible with Goals A,B,C, and D, opportunities for fish and wildlife oriented recreation.

Objective E-1: To evaluate sport fishing use and success on roadside lakes and streams through 2000.

Objective E-2: To provide a variety of recreational fishing opportunities on the refuge through 2000.

SECTION 7. STRATEGIES AND CONSTRAINTS

Common Management Direction

Strategies and constraints considered in developing this fishery management plan reflect policy guidance provided on a national and regional level and in the Kenai Refuge Comprehensive Conservation Plan. The Service has adopted a national policy (U.S. Fish and Wildlife Service 1988) to provide increased recreational fishing opportunities on national wildlife refuges. The Kenai Refuge staff is complying with this policy by providing a variety of fishing opportunities refuge-wide.

In the Kenai Refuge Comprehensive Conservation Plan, refuge lands were divided into areas managed under five different management categories. A set of refuge management strategies was developed for each land management category (in light of its resources and existing and potential uses) to facilitate management and accomplishment of overall refuge purposes. Table 11 provides a brief description of how the refuge will be managed under each land management category. In addition, the following fishery management concepts can be applied under the various land management categories:

Sustained Yield.—This concept applies to waters where management is primarily directed toward providing anglers with the opportunity to harvest fish. Sustained yield fisheries may be restored by stocking, but the yield to the angler is a fish which grows to catchable size in the wild. The opportunity to catch trophy fish or wild fish is not a major intent of this concept, even though base yield fisheries are supported by natural reproduction and trophy fish species occasionally enter the catch.

Wild.—This concept applies to waters where management is primarily directed toward maintaining long term commercial and sport fisheries that are totally supported by natural reproduction relying upon existing refuge stocks. Harvest is managed to ensure adequate escapement levels to sustain the current fisheries. Either no harvest or limited harvest of spawning adults is expected in spawning areas.

Trophy.—This concept applies to waters where management is primarily directed toward providing the angler with the opportunity to catch "larger than average" fish. A water that typically produces larger than average fish is not necessarily a trophy water unless this is a major objective of present and future management. In order to be managed under the trophy concept, a water must have relatively high productivity and/or abundant forage, management procedures such as restrictive creel limits, and limitations on fishing pressure are usually employed.

Table 11.— Comparison of the land management categories for managing the Kenai National Wildlife Refuge (U.S. Fish and Wildlife Service 1985).

	Intensive Management	Moderate Management	Traditional Management	Minimal Management	Wilderness Management
The Physical setting would be.....	noticeably altered and dominated by the works of man	natural appearing, balancing the works of man and nature	natural and dominated by the works of nature	pristine and unmodified	pristine and unmodified
Natural processes would	be substantially altered through habitat manipulation	be occasionally altered through habitat manipulation	play a primary role	be dominant	be dominant
50 Fish and wildlife populations would.....	emphasize species of high public interest	balance species of high public interest and natural population dynamics	emphasize natural population dynamics	be dominated by natural population dynamics	be dominated by natural population dynamics
Recreational experiences focus on.....	affiliation with individuals or groups, with convenience of both access and sites	equal opportunity for either group involvement or isolation with convenience of access	solitude, risk, challenge, and reliance on outdoor skills in an accessible setting	solitude, risk, challenge, and reliance on outdoor skills	solitude, risk, challenge, and reliance on outdoor skills

Put, Grow, and Take.—This concept applies to waters where management is directed toward allowing the angler to consumptively harvest non-anadromous fish. All of the harvest from waters managed under this concept is comprised of fish which are stocked as fry or fingerlings from a fish hatchery. Most waters managed for put, grow, and take lack the potential for natural reproduction of salmonids and thus, must be supported by repeated stocking. Put, grow, and take waters can be managed to sustain high visitor use.

Commercial Enhancement.—This concept applies to waters where management is primarily directed toward maintaining commercial fisheries relying, in part, upon artificially produced fish and a supplement to the stock. This concept may incorporate habitat alteration including barrier removal, construction and installation of fishways, weirs, fish hatching and rearing facilities, and spawning channels. Annual stocking may be required to maintain fish stocks at a sustained level. Some sport and subsistence harvest of the enhanced fish may occur.

Fishery management activities may be applied only if they are compatible with established purposes of the refuge. Application of the fishery management strategies will occur as a cooperative effort between the Department and the Service. Day-to-day operations are guided by a Memorandum of Understanding between the Service and the Department dated March 13, 1982 (Appendix 2).

The Service and the Department will cooperate in the collection of fishery management data from refuge originating species. Cooperative efforts to maintain fish counting weirs and sonar sites and to conduct aerial surveys and creel surveys will continue. The large refuge land base and abundance of fish species occurring on the refuge requires the sharing of law enforcement responsibilities. The State's Department of Public Safety, Division of Fish and Wildlife Protection, will enforce state regulations within and adjacent to the refuge. Refuge officers will either issue federal citations or transfer to state jurisdiction violations of state laws occurring within the refuge boundaries.

The Service and Department will cooperatively evaluate the results of field studies and surveys with respect to both refuge originating and resident species. The Service will confer and work with the Department on a local level in the interpretation of the results and the development of future management direction. The Service may recommend changes in state regulations when biological information indicates that fish or wildlife populations are adversely impacted or goals are not being met.

Fishery Management Strategies

Fisheries management on the refuge will be directed toward maintaining, to the maximum extent possible, the natural diversity of fish and wildlife populations and their habitats throughout the refuge.

Presently, the majority of fish populations on the refuge are managed under the "wild" concept of fisheries management. Other management concepts currently in place include: 1) commercial enhancement of sockeye salmon populations in Hidden and Tustumena lakes; 2) a trophy rainbow trout fishery in the Kenai River upstream of Skilak Lake; and 3) sustained yield fisheries in most road accessible lakes.

The emphasis of fishery management on the refuge over the next five years will be directed toward: 1) collecting baseline data on important fish populations and watersheds; 2) protection and rehabilitation of streambanks damaged from human foot traffic; 3) developing a better public information and education program; and 4) evaluating sport fishing use and success on roadside lakes and streams.

Incomplete Baseline of Fishery Information

Little is known about the fish populations occurring in some refuge rivers, streams, and lakes. Given the relatively high commercial and recreational use of fish originating on the refuge and adjacent lands, it is important to document fishery resources in these areas. Data collection will concentrate on quantifying general community structure (species composition, relative abundance, and distribution), population dynamics of important species, spawning and rearing habitats of selected species, and developing a water quality and quantity data base.

Protection and Rehabilitation of Streambanks

A primary concern regarding high levels of public use on the Kenai Refuge is damage to streambanks caused by anglers and others standing, walking, or camping along the shoreline. Streambanks that are being damaged from large amounts of foot traffic will be identified and various methods for rehabilitation will be examined. Measures taken to reduce streambank erosion could include access restrictions, boardwalk and trail construction, educational signs, revegetation, and implementation of "no-wake" or "non-motorized" restrictions.

Better Public Information and Education

The public information and education program will be improved to help the general public become better informed and educated about fundamental aspects of fisheries biology and ecology. Particular efforts will be made to heighten public awareness of threats to aquatic habitats. Emphasis will be directed toward development of educational materials, construction of information kiosks, and participation in National Fishing Week activities.

Sport Fishing Use

Projects will be designed to quantify fisheries related public use occurring on identified watersheds. Information will be collected on sport fishing effort, catch, and age and size structure of the harvest.

Data collected will be used to evaluate individual fisheries and recommend regulation changes or other remedial measures if needed.

Constraints to Management

In implementing these strategies, the following constraints must be considered for anadromous and resident species: 1) more complete information is needed to properly manage some fisheries; 2) limited funds and personnel are available to obtain needed information; 3) regulatory changes needed to meet objectives may conflict with the desires of some user groups; 4) regulations will be difficult to enforce, especially in remote areas; 5) resistance may be met in gathering information from user groups; and 6) refuge purposes and Department goals and objectives may not be compatible.

SECTION 8. FISHERY MANAGEMENT PROGRAM

Goals Objectives	Tasks	Responsible Office	Date/Funding/FTE
Goal A. Conserve fish and wildlife populations and habitats in their natural diversity including but not limited to salmonids.			
Objective A-1. To administer the fishery management program on the Kenai Refuge as a continuing commitment through 2000.	Task A-1-1. Meet legal mandates with respect to refuge fisheries. Prepare management recommendations, attend planning meetings, prepare news releases, issue Special Use permits, and coordinate both intra- and interagency fisheries matters.	Kenai FRO ¹ Kenai Refuge	1996/10,000/0.2 1997/10,000/0.2 1998/12,000/0.2 1999/12,000/0.2 2000/12,000/0.2
	Task A-1-2. Provide technical assistance to Kenai Refuge staff.	Kenai FRO	1996/12,000/0.2 1997/12,000/0.2 1998/15,000/0.2 1999/15,000/0.2 2000/15,000/0.2
Objective A-2. To manage the harvest of refuge fish populations in accordance with agency regulations as a continuing commitment through 2000.	Task A-2-1. Regulate and monitor commercial salmon harvests by district and season.	ADFG-Comm. Fish ²	Continuing Effort
	Task A-2-2. Regulate and monitor sport fish harvests.	ADFG-Sport Fish ³	Continuing Effort
	Task A-2-3. Regulate and monitor personal use fisheries.	ADFG-Comm. Fish	Continuing Effort

SECTION 8 (continued).

Goals Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-3. To monitor and evaluate refuge salmon stocks through 2000.	Task A-2-4. Propose modifications of fish harvest regulations to the Alaska Board of Fisheries.	Kenai Refuge ADFG Kenai FRO	Continuing Effort
	Task A-2-5. Conduct fishery law enforcement activities.	Kenai Refuge Fish and Wildlife Protection ⁴	1996/40,000/0.8 1997/40,000/0.8 1998/45,000/0.8 1999/45,000/0.9 2000/45,000/0.9
	Task A-3-1. Operate a counting weir on the Russian River to enumerate sockeye salmon.	ADFG-Sport Fish	Continuing Effort
	Task A-3-2. Operate a sonar counter and fish wheel on the Kenai River to monitor escapement of sockeye salmon.	ADFG-Comm. Fish	Continuing Effort
	Task A-3-3. Operate a sonar counter on the Kenai River to monitor escapement of chinook salmon.	ADFG-Sport Fish	Continuing Effort
	Task A-3-4. Develop a method to enumerate coho salmon in the Kenai River.	ADFG-Sport Fish	Continuing Effort
	Task A-3-5. Operate a sonar counter and fish wheel on the Kasilof River to monitor escapement of sockeye salmon.	ADFG-Comm. Fish	Continuing Effort

SECTION 8 (continued).

Goals Objectives	Tasks	Responsible Office	Date/Funding/FTE
	Task A-3-6. Conduct stock separation studies for sockeye salmon.	ADFG-Comm. Fish	Continuing Effort
	Task A-3-7. Conduct stock separation studies for coho salmon.	ADFG-Sport Fish	Continuing Effort
	Task A-3-8. Estimate escapement of late-run chinook and coho salmon in the Kasilof River.	Kenai FRO ADFG-Sport Fish	1998/80,000/0.8 1999/50,000/0.8 2000/50,000/0.8
	Task A-3-9. Estimate escapement of all salmon runs in the Chickaloon River.	Kenai FRO ADFG-Sport Fish	1996/80,000/0.8 1997/50,000/0.8 1998/50,000/0.8
	Task A-3-10. Conduct aerial surveys on Benjamin Creek.	ADFG-Sport Fish	Continuing Effort
	Task A-3-11. Trap outmigrating sockeye salmon smolts in the Kenai and Kasilof rivers to determine run strength.	ADFG-Comm. Fish	Continuing Effort
	Task A-3-12. Trap outmigrating coho salmon smolts in the Kenai River to assess stock status.	ADFG-Sport Fish	Continuing Effort
	Task A-3-13. Trap chinook salmon parr in the Kenai River and mark with coded wire tags to assess contribution to Cook Inlet marine fishery.	ADFG-Sport Fish	Continuing Effort

SECTION 8 (continued).

Goals Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-4. To complete basic fishery resource inventories for major lakes and streams on the refuge by 2000.	Task A-3-14. Conduct limnological and hydroacoustic surveys of Skilak and Kenai lakes.	ADFG-Comm. Fish	Continuing Effort
	Task A-3-15. Estimate population size and structure of coho salmon in the Hidden Creek drainage.	Kenai FRO	1996/20,000/0.3 1997/20,000/0.3
	Task A-4-1. Conduct fishery surveys on the Killey River.	Kenai FRO ADFG-Sport Fish	1997/50,000/0.6 1998/50,000/0.6
	Task A-4-2. Conduct fishery surveys on the Funny River.	Kenai FRO ADFG-Sport Fish	1997/50,000/0.6 1998/50,000/0.6
	Task A-4-3. Conduct fishery surveys on Crooked and Nikolai creeks.	Kenai FRO	1996/30,000/0.6 1997/30,000/0.6
	Task A-4-4. Conduct fishery surveys on Sheep Creek.	Kenai FRO	1999/30,000/0.5 2000/30,000/0.5
	Task A-4-5. Conduct fishery surveys on Big and Little Indian creeks.	Kenai FRO ADFG-Sport Fish	1999/30,000/0.5 2000/30,000/0.5

SECTION 8 (continued).

Goals Objectives	Tasks	Responsible Office	Date/Funding/FTE
Objective A-5. To evaluate sockeye salmon enhancement efforts on refuge waters through 2000.	Task A-4-6. Conduct fishery surveys on lakes and streams in watersheds north of the Sterling Highway including Seven Egg, Pincher, Otter, Scaup, Bedlam, Miller, and Dipper creeks. This task would include reexamination of some lakes in the Swanson, Moose, and Chickaloon river watersheds.	Kenai FRO ADFG-Sport Fish	1999/75,000/0.6 2000/75,000/0.6
	Task A-5-1. Conduct hydroacoustic and limnological surveys on Tustumena Lake.	ADFG-Comm. Fish	Continuing Effort
	Task A-5-2. Take eggs, stock fry, enumerate sockeye salmon smolts and returning adults, and examine the distribution of spawning adult sockeye salmon in Tustumena Lake and tributaries.	ADFG-Comm. Fish	This task is contingent upon an environmental assessment (Task A-5-3).
	Task A-5-3. Conduct an environmental assessment of the sockeye salmon enhancement effort on Tustumena Lake.	ADFG-Comm. Fish Kenai Refuge Kenai FRO	1996 (Funding for federal responsibilities included under Tasks A-1-1 and A-1-2.)

SECTION 8 (continued).

Goals Objectives	Tasks	Responsible Office	Date/Funding/FTE
	Task A-5-4. Take eggs, stock fry, enumerate sockeye salmon smolts and returning adults to Hidden Lake.	ADFG-Comm. Fish	Continuing Effort
Objective A-6. To determine the population dynamics of rainbow trout in the Kenai River by 1997.	Task A-6-1. Examine population structure and movement patterns.	ADFG-Sport Fish Kenai FRO	1996/30,000/0.6 1997/30,000/0.6
Objective A-7. To determine the population dynamics of Dolly Varden in the Kenai River by 1997.	Task A-7-1. Examine population structure and movement patterns.	ADFG-Sport Fish Kenai FRO	1996/30,000/0.6 1997/30,000/0.6
Objective A-8. To reduce bank trampling and prevent loss of riparian vegetation on rivers receiving high sport fishing use by 2000.	Task A-8-1. Examine measures to rehabilitate and stabilize streambanks on the Kenai and Russian rivers and identify potential streambanks for rehabilitation.	Kenai Refuge Kenai FRO	1996/30,000/0.2
	Task A-8-2. Conduct streambank rehabilitation projects on the Kenai and Russian rivers.	Kenai Refuge Kenai FRO	1997/200,000/0.5 1998/200,000/0.5 1999/200,000/0.5 2000/200,000/0.5
Objective A-9. To monitor the northern pike population in the Moose River through 2000.	Task A-9-1. Conduct surveys on the Moose River to determine the abundance and distribution of northern pike.	Kenai FRO	1999/20,000/0.3 2000/20,000/0.3

SECTION 8 (continued).

Goals Objectives	Tasks	Responsible Office	Date/Funding/FTE
Goal B. Fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats.			
No objective were identified.			
Goal C. Ensure, to the maximum extent practicable and in a manner consistent with Goal A, water quality and necessary water quantity within the refuge.			
Objective C-1. To develop a water quality and quantity data base for major lakes and streams on the refuge by 2000.	Task C-1-1. Gather water quality data and measure physical characteristics of unsurveyed streams and lakes (In conjunction with Objective A-4).	Kenai FRO	Funding included under Tasks A-4-1 through A-4-6.
Objective C-2. To monitor water quality in the Kenai River drainage as a continuing commitment through 2000.	Task C-2-1. Participate in the Kenai Peninsula Groundwater Task Force.	Kenai FRO	Continuing Effort
	Task C-2-2. Monitor water quality in the Kenai River.	Kenai Refuge Kenai FRO ADFG-Limnology Lab	1996/20,000/0.2 1997/20,000/0.2 1998/20,000/0.2 1999/20,000/0.2 2000/20,000/0.2

SECTION 8 (continued).

Goals Objectives	Tasks	Responsible Office	Date/Funding/FTE
Goal D. Provide, in a manner consistent with Goals A and B, opportunities for scientific research, interpretation, environmental education, and land management training.			
Objective D-1. To provide opportunities for the public to learn about fishery resources and aquatic habitats through 2000.	Task D-1-1. Participate in National Fishing Week activities.	Kenai Refuge Kenai FRO	Continuing Effort
	Task D-1-2. Develop and construct kiosks which describe the importance of shoreline habitats to fish populations.	Kenai Refuge Kenai FRO	1996/40,000/0.2
	Task D-1-3. Develop a watershed/habitat based school curriculum.	External Affairs ⁵	1999/100,000/0.5
	Task D-1-4. Develop a video describing threats to aquatic habitats.	Kenai FRO	1997/100,000/0.5
	Task D-1-5. Recruit volunteers to assist on refuge fishery projects.	Kenai FRO Kenai Refuge	Continuing Effort
Goal E. Provide, in a manner compatible with Goals A, B, C, and D, opportunities for fish and wildlife oriented recreation.			
Objective E-1. To evaluate sport fishing use and success on roadside lakes and streams through 2000.	Task E-1-1. Conduct creel surveys on Hidden Lake.	Kenai FRO	1996/5,000/0.1

SECTION 8 (continued).

Goals Objectives	Tasks	Responsible Office	Date/Funding/FTE
	Task E-1-2. Conduct creel surveys on the Russian River.	ADFG-Sport Fish	Continuing Effort
	Task E-1-3. Conduct creel surveys on the upper and middle sections of the Kenai River.	Kenai FRO	1998/30,000/0.4
	Task E-1-4. Conduct creel surveys on the lower Kenai River.	ADFG-Sport Fish	Continuing Effort
	Task E-1-5. Conduct creel surveys on the Swanson River.	Kenai FRO	2000/15,000/0.2
Objective E-2. To provide a variety of recreational fishing opportunities on the refuge through 2000.	Task E-2-1. Produce a brochure describing recreational fishing opportunities on the refuge.	Kenai Refuge Kenai FRO	1998/10,000/0.1
	Task E-2-2. Locate waters suitable for "trophy", "catch and release", and "put, grow, and take" programs.	Kenai FRO Kenai Refuge ADFG-Sport Fish	Continuing Effort

¹ Kenai Fishery Resource Office

² Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division

³ Alaska Department of Fish and Game, Division of Sport Fish

⁴ Alaska Department of Public Safety, Division of Fish and Wildlife Protection

⁵ U.S. Fish and Wildlife Service, Alaska Regional Office, External Affairs Office

SECTION 9. PRIORITY OF TASKS

Priority of tasks and funding for fishery management activities to be conducted by the U.S. Fish and Wildlife Service on the Kenai National Wildlife Refuge, 1996-2000.

Priority	Task	Funding	Cumulative Total	Responsible Office
1996				
1. A-1-1.	Fishery program administration	10,000	10,000	Kenai FRO Kenai Refuge
2. A-1-2.	Provide technical assistance to refuge	12,000	22,000	Kenai FRO
3. A-8-1.	Examine measures to rehabilitate streambanks and identify potential streambanks for rehabilitation	30,000	52,000	Kenai Refuge Kenai FRO
4. A-6-1.	Population study of rainbow trout in Kenai River	30,000	82,000	Kenai FRO
5. A-7-1.	Population study of Dolly Varden in Kenai River	30,000	112,000	Kenai FRO
6. D-1-2.	Develop and construct habitat kiosks	40,000	152,000	Kenai Refuge Kenai FRO
7. A-4-3.	Baseline survey of Crooked and Nikolai creeks	30,000	182,000	Kenai FRO
8. C-2-2.	Monitor water quality in the Kenai River	20,000	202,000	Kenai Refuge Kenai FRO
9. A-3-15.	Population study of coho salmon in Hidden Creek	20,000	222,000	Kenai FRO
10. A-2-5.	Conduct fishery law enforcement activities	40,000	262,000	Kenai Refuge
11. E-1-1.	Creel survey on Hidden Lake	5,000	267,000	Kenai FRO
12. A-3-9.	Salmon escapement estimates on Chickaloon River	80,000	347,000	Kenai FRO

SECTION 9 (continued).

Priority	Task	Funding	Cumulative Total	Responsible Office
1997				
1. A-1-1.	Fishery program administration	10,000	10,000	Kenai FRO Kenai Refuge
2. A-1-2.	Provide technical assistance to refuge	12,000	22,000	Kenai FRO
3. A-8-2.	Conduct streambank rehabilitation projects	200,000	222,000	Kenai Refuge Kenai FRO
4. A-6-1.	Population study of rainbow trout in Kenai River	30,000	252,000	Kenai FRO
5. A-7-1.	Population study of Dolly Varden in Kenai River	30,000	282,000	Kenai FRO
6. A-4-3.	Baseline survey of Crooked and Nikolai creeks	30,000	312,000	Kenai FRO
7. D-1-4.	Develop a video on threats to aquatic habitats	100,000	412,000	Kenai FRO
8. C-2-2.	Monitor water quality in the Kenai River	20,000	432,000	Kenai Refuge Kenai FRO
9. A-3-15.	Population study of coho salmon in Hidden Creek	20,000	452,000	Kenai FRO
10. A-2-5.	Conduct fishery law enforcement activities	40,000	492,000	Kenai Refuge
11. A-3-9.	Salmon escapement estimates on Chickaloon River	50,000	542,000	Kenai FRO
12. A-4-1.	Baseline survey of Killey River	50,000	592,000	Kenai FRO
13. A-4-2.	Baseline survey of Funny River	50,000	642,000	Kenai FRO

SECTION 9 (continued).

Priority	Task	1998			Responsible Office
		Funding	Cumulative Total		
1.	A-1-1. Fishery program administration	12,000	12,000		Kenai FRO Kenai Refuge
2.	A-1-2. Provide technical assistance to refuge	15,000	27,000		Kenai FRO
3.	A-8-2. Conduct streambank rehabilitation projects	200,000	227,000		Kenai Refuge Kenai FRO
4.	C-2-2. Monitor water quality in the Kenai River	20,000	247,000		Kenai Refuge Kenai FRO
5.	A-2-5. Conduct fishery law enforcement activities	45,000	292,000		Kenai Refuge
6.	E-1-3. Creel surveys on upper and middle Kenai River	30,000	322,000		Kenai FRO
7.	A-3-8. Salmon escapement estimates on Kasilof River	80,000	402,000		Kenai FRO
8.	E-2-1. Produce a recreational fishing opportunity brochure	10,000	412,000		Kenai Refuge Kenai FRO
9.	A-3-9. Salmon escapement estimates on Chickaloon River	50,000	462,000		Kenai FRO
10.	A-4-1. Baseline survey of Killey River	50,000	512,000		Kenai FRO
11.	A-4-2. Baseline survey of Funny River	50,000	562,000		Kenai FRO

SECTION 9 (continued).

Priority	Task	Funding	Cumulative Total	Responsible Office
1999				
1. A-1-1.	Fishery program administration	12,000	12,000	Kenai FRO Kenai Refuge
2. A-1-2.	Provide technical assistance to refuge	15,000	27,000	Kenai FRO
3. A-8-2.	Conduct streambank rehabilitation projects	200,000	227,000	Kenai Refuge Kenai FRO
4. D-1-3.	Develop a watershed/habitat based school curriculum	100,000	337,000	External Affairs
5. C-2-2.	Monitor water quality in the Kenai River	20,000	357,000	Kenai Refuge Kenai FRO
6. A-2-5.	Conduct fishery law enforcement activities	45,000	402,000	Kenai Refuge
7. A-3-8.	Salmon escapement estimates on Kasilof River	50,000	452,000	Kenai FRO
8. A-4-5.	Baseline survey of Big Indian and Little Indian creeks	30,000	482,000	Kenai FRO
9. A-9-1.	Determine abundance and distribution of northern pike in the Moose River	20,000	502,000	Kenai FRO
10. A-4-6.	Lake and stream surveys north of the Sterling Highway	75,000	577,000	Kenai FRO
11. A-4-4.	Baseline survey of Sheep Creek	30,000	607,000	Kenai FRO

SECTION 9 (continued).

Priority	Task	2000	Funding	Cumulative Total	Responsible Office
1.	A-1-1. Fishery program administration		12,000	12,000	Kenai FRO Kenai Refuge
2.	A-1-2. Provide technical assistance to refuge		15,000	27,000	Kenai FRO
3.	A-8-2. Conduct streambank rehabilitation projects		200,000	227,000	Kenai Refuge Kenai FRO
4.	C-2-2. Monitor water quality in the Kenai River		20,000	247,000	Kenai Refuge Kenai FRO
5.	A-2-5. Conduct fishery law enforcement activities		45,000	292,000	Kenai Refuge
6.	A-3-8. Salmon escapement estimates on Kaslof River		50,000	342,000	Kenai FRO
7.	A-4-5. Baseline survey of Big Indian and Little Indian creeks		30,000	372,000	Kenai FRO
8.	A-9-1. Determine abundance and distribution of northern pike in the Moose River		20,000	392,000	Kenai FRO
9.	E-1-5. Creel surveys on Swanson River		15,000	407,000	Kenai FRO
10.	A-4-6. Lake and stream surveys north of the Sterling Highway		75,000	482,000	Kenai FRO
11.	A-4-4. Baseline survey of Sheep Creek		30,000	512,000	Kenai FRO

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APPENDIX 1

MEMORANDUM OF UNDERSTANDING

BETWEEN

THE STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
Juneau, Alaska

AND

THE U.S. DEPARTMENT OF INTERIOR
FISH AND WILDLIFE SERVICE
Alaska Region

AND

THE U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Alaska Region

This Memorandum of Understanding between the State of Alaska, Department of Natural Resources, hereinafter referred to as the Department, and the United States Department of Interior, Fish and Wildlife Service, hereinafter referred to as the Service, United States Department of Agriculture, Forest Service, hereinafter referred to as the Forest Service, reflects the general policy guidelines within which the three agencies agree to operate in relation to the land, including submerged, tide and shoreland, and water of the Kenai River.

WHEREAS, the Department, under the Constitution, laws, and regulations of the State of Alaska, is responsible for supervision, improvement, development and maintenance of the State Park System, and furthermore, the Department is assigned responsibility by A.S. 41.21.500-514 for the control, maintenance, and development of the Kenai River Special Management Area, a unit of the State Park system; and

WHEREAS, the Service, under the Constitution, laws of Congress, and regulations of the U.S. Department of the Interior, is responsible on the Kenai National Wildlife Refuge to conserve fish and wildlife populations and habitats in their natural diversity, ensure water quality and quantity, fulfill international treaty obligations with respect to fish and wildlife and their habitats, and to provide in a manner compatible with these responsibilities, opportunities for scientific research, interpretation, environmental education, land management training, and opportunities for fish and wildlife-oriented recreation; and

WHEREAS, the Forest Service, by authority of the Multiple-Use Sustained-Yield Act of 1960, the Sikes Act of 1974, and the Economy Act of 1932, is responsible for the administration and multiple-use management of the natural resources within the boundaries of the Chugach National Forest, this management including the maintenance and improvement of habitat for fish and wildlife, the protection of historical and cultural resources, timber harvest and recreational opportunities in concert with other recognized uses and users of the lands and waters; and

WHEREAS, the Department, the Service, and the Forest Service share a mutual concern for protection of the fish and wildlife resources and their habitats, and for providing recreational opportunities for the visiting public, and desire to develop and maintain a cooperative relationship which will be in the best interests of all parties, the concerned fish and wildlife resource and their habitats, and produce the greatest public benefit; and

WHEREAS, the Department, the Service, and the Forest Service recognize the increasing need to coordinate resource planning and policy development for the lands and waters of the Kenai River.

NOW, THEREFORE, THE PARTIES HERETO HEREBY AGREE AS FOLLOWS:

1. To the extent consistent with and allowed by each party's applicable laws, regulations, and policies, to recognize the planning, enforcement, and permit authority of each other party with respect to the lands and waters each party may manage on or near the Kenai River (including Skilak and Kenai lakes).
2. To make their best efforts to protect the fish and wildlife habitats and productivity and public fish and wildlife oriented recreational values of the aforementioned lands and waters insofar as such efforts are consistent with the applicable laws, regulations and plans of each party.
3. To support each party's management efforts insofar as those management efforts do not conflict with the applicable laws, regulations and plans governing the cooperating party's conduct.
4. To coordinate planning for management of fish and wildlife resources, recreational resources, and associated resources so that potential conflicts arising from differing legal mandates, objectives, and policies are recognized early in the planning process and are avoided or minimized.
5. To consult with each other when developing policy, regulations, or legislation which affects the development and protection of the natural, cultural, historical, recreational, and scenic resources of the Kenai River (including Skilak and Kenai lakes).

6. To consult with each other to resolve differences or potential differences, and to promote effective cooperation regarding the management of natural, cultural, historical, recreational, and scenic resources of the Kenai River (including Skilak and Kenai lakes).
7. To pursue the feasibility of combined cooperative permitting systems for public use activities for the purpose of simplifying the procedures for permit issuance.
8. To pursue the feasibility of joint law enforcement authority and mutual enforcement of applicable State and Federal laws, regulations, and permit stipulations for public use activities on the Kenai River (including Skilak and Kenai lakes).
9. To develop such cooperative/interagency or memoranda of understanding between the parties as may be required to implement the policies contained herein or as needed to address other operational matters.
10. That this Memorandum of Understanding shall become effective when signed by the Commissioner of the Alaska Department of Natural Resources, the Alaska Regional Director of the U.S. Fish and Wildlife Service, and the Regional Forester of the USDA Forest Service, Alaska Region and shall continue in force until terminated by a signatory party by providing notice in writing 120 days in advance of the intended date of termination.
11. That nothing in this agreement shall obligate any party in the expenditure of funds, or for future payments of money in excess of appropriations authorized by law.
12. That amendments to this Memorandum of Understanding may be proposed by any party to this agreement and shall become effective upon written approval by the authorized representative for each party.
13. That all parties through their designated representatives, will meet at least twice each year on or about November 1, and April 1.
14. That nothing in this agreement is intended to enlarge or diminish the responsibility and authority of the State of Alaska or the Secretary of Interior or the Secretary of Agriculture over the management of any lands, waters, and/or interests therein.
15. That nothing in this agreement is intended to enlarge or diminish the responsibility and authority of the State of Alaska or the Secretary of Interior or the Secretary of Agriculture over the management of fish and wildlife and their habitats.

16. That nothing in this agreement is intended to enlarge or diminish the responsibility and authority of the State of Alaska or of the Secretary of Interior or the Secretary of Agriculture of any laws, regulations, or permit conditions.

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES

/s/ Esther C. Wunnicke 9/22/86
ESTHER C. WUNNICKE DATE
Commissioner

U.S. DEPARTMENT OF INTERIOR
FISH AND WILDLIFE SERVICE

/s/ Robert E. Gilmore
ROBERT E. GILMORE DATE
Regional Director, Alaska

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

/s/ Michael A. Barton 10/2/86
MICHAEL BARTON DATE
Regional Forester, Alaska Region

APPENDIX 2

MASTER MEMORANDUM OF UNDERSTANDING
BETWEEN
THE ALASKA DEPARTMENT OF FISH AND GAME
Juneau, Alaska
AND
THE U.S. FISH AND WILDLIFE SERVICE
DEPARTMENT OF INTERIOR
Anchorage, Alaska

This Master Memorandum of Understanding between the State of Alaska, Department of Fish and Game, hereinafter referred to as the Department, and the U.S. Fish and Wildlife Service, hereinafter referred to as the Service, reflects the general policy guidelines within which the two agencies agree to operate.

WHEREAS, the Department, under the Constitution, laws and regulations of the State of Alaska, is responsible for the management, protection, maintenance, enhancement, rehabilitation, and extension of the fish and wildlife resources of the State on a sustained yield principle, subject to preferences among beneficial uses; and

WHEREAS, the Service, by authority of the Constitution, laws of Congress and regulations of the U.S. Department of Interior has mandated management responsibility for certain species or classes of wildlife and is responsible for the management of Service lands in Alaska, and the conservation of fish and wildlife resources on these lands; and

WHEREAS, the Department and the Service share a mutual concern for fish and wildlife resources and their habitats and both are engaged in extensive fish and wildlife conservation, management, and protection programs and desire to develop and maintain a cooperative relationship which will be in the best interest of both parties, the concerned fish and wildlife resources and their habitats, and produce the greatest public benefit; and

WHEREAS, it has been recognized in the Alaska National Interest Lands Conservation Act and subsequent implementing Federal regulations that the resources and use of Service lands in Alaska are substantially different than those of other states; and

WHEREAS, the Department and the Service recognize the increasing need to coordinate resource planning and policy development;

NOW, THEREFORE, the parties hereto hereby agree as follows:

THE DEPARTMENT OF FISH AND GAME AGREES:

1. To recognize the Service as the agency with the responsibility to manage migratory birds, endangered species, and other species

mandated by Federal law, and on Service lands in Alaska to conserve fish and wildlife and their habitats and regulate human use.

2. To manage fish and resident wildlife populations in their natural diversity on Service lands.
3. To consult with the Regional Director in a timely manner and comply with applicable Federal laws and regulations before embarking on enhancement or construction activities on Service lands.

THE FISH AND WILDLIFE SERVICE AGREES:

1. To recognize the Department as the agency with the primary responsibility to manage fish and resident wildlife within the State of Alaska.
2. To recognize the right of the Department to enter Service lands at any time to conduct routine management activities which do not involve construction, disturbance to the land, or alterations of ecosystems.
3. To cooperate with the Department in planning for enhancement or development activities on Service lands which require permits, environmental assessments, compatibility assessments, or similar regulatory documents by responding to the Department in a timely manner with requirements, time tables, and any other necessary input.
4. To manage the fish and wildlife habitat on Service lands so as to insure conservation of fish and wildlife populations and their habitats in their natural diversity.
5. To consider carefully the impact of any proposed treaties or international agreements relating to fish and wildlife resources on the State of Alaska which could diminish the jurisdictional authority of the State and to consult freely with the State when these treaties or agreements have a primary impact on the State.
6. To review present U.S. Fish and Wildlife Service policies and any future proposed changes in those policies in consultation with the Department to determine if modified or special policies are needed for Alaska.
7. To adopt refuge management plans whose provisions--including provision for animal damage control--are in substantial agreement with the Department's fish and wildlife management plans, unless such plans are determined formally to be incompatible with the purposes for which the respective refuges were established.

8. To utilize the State's regulatory process to the maximum extent allowed by Federal law in developing new or modifying existing Federal regulations or proposing changes in existing State regulations governing or affecting the taking of fish and wildlife on Service lands in Alaska.

THE DEPARTMENT OF FISH AND GAME AND THE FISH AND WILDLIFE SERVICE
MUTUALLY AGREE:

1. To coordinate planning for management of fish and wildlife resources on Service lands so that conflicts arising from differing legal mandates, objectives, and policies either do not arise or are minimized.
2. To consult with each other when developing policy and legislation which affects the attainment of wildlife resource management goals and objectives, or management plans.
3. To recognize that the taking of fish and wildlife by hunting, trapping, or fishing on Service lands in Alaska is authorized in accordance with applicable State and Federal law unless State regulations are found to be incompatible with documented Refuge goals, objectives, or management plans.
4. To develop such supplemental memoranda of understanding between the Commissioner and the Regional Director as may be required to implement the policies contained herein.
5. That this Master Memorandum of Understanding shall become effective when signed by the Commissioner of the Alaska Department of Fish and Game and the Alaska Regional Director of the U.S. Fish and Wildlife Service and shall continue in force until terminated by either party by providing notice in writing 120 days in advance of the intended date of termination.
6. That amendments to this Master Memorandum of Understanding may be proposed by either party and shall become effective upon approval by both parties.

STATE OF ALASKA

Department of Fish and Game

Ronald O. Skoog
Commissioner

March 13, 1982
Date

U.S. DEPARTMENT OF
THE INTERIOR

Fish and Wildlife Service

Keith M. Schreiner
Regional Director, Alaska

March 13, 1982
Date

CONCURRENCE AND APPROVAL PAGE

Project Leader: *Sam M. Senn* Date: 6/16/95
~~Kenai~~ Fishery Resource Office

Refuge Manager: *Daniel W. Dutton* Date: 6/19/95
 Kenai National Wildlife Refuge

Assistant
 Regional Director: *Steph L. Ricketts* Date: 7/5/95
 Fisheries and Federal Aid

^{3rd}
 Acting Assistant
 Regional Director: *Bob L. West* Date: 8/31/95
 Refuges and Wildlife

Regional Director: *Dan B. Allen* Date: 8/31/95

